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Examining Teachers' Lesson Plans Following Universal Design for Learning Training

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Walden University

College of Education

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Georgeann Winter

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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Walden University
2016

Abstract

Examining Changes in Teachers' Lesson Plans Following Universal Design for Learning
Training

by

Georgeann Winter

MS, Walden University, 2011

BS, South Dakota School of Mines and Technology, 1996

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

With a growing population of culturally and academically diverse student populations in K – 12 education, Universal Design for Learning (UDL) has the potential to improve the quality of teaching and learning for all students. However, there is a lack of research on UDL teacher in-service training to determine whether teachers are more effective at implementing UDL once they receive adequate training. The purpose of this quantitative study was to examine changes in teachers' lesson plans following UDL professional training. Seventeen teachers from 5 school districts in the state of Mississippi participated in the study. Teachers' lesson plans were evaluated at 3 time points using a valid UDL lesson plan rubric from a previous study. Data were collected before the intervention, immediately after the intervention, and 2 months after the intervention was administered. A within-subjects MANOVA with repeated measurement was conducted comparing pretreatment and post-treatment scores for each of the 4 dependent variables (total score and representation, expression, and engagement scores) to examine the changes in lesson planning following UDL professional training. The results showed a significant difference in teachers' lesson plans between conditions for each of the 4 dependent variables. The social change objective for this study was to improve the quality of teaching and learning in mixed-ability classrooms.

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Dedication

This dissertation is dedicated to my son, David, for showing me the meaning of the word, *empathy*, and to my students who were the best teachers I ever had.

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Chapter 1: Introduction to the Study

Introduction

The kindergarten through 12th grade (K–12) student population in the United States has become more culturally and academically diverse in the past 3 decades (Gordon, Gravel, & Schifter, 2009). Federal legislation, the Every Student Succeeds Act (ESSA; 2015) and Individuals with Disabilities Education Act (IDEA; 2004), mandate that all students be provided a high-quality education based on the same state standards and accountability measures. With these changes, it has become increasingly difficult for teachers to accommodate the academic needs of a diverse student population (Gordon et al., 2009).

To be successful at engaging all learners and to communicate the standards-based curriculum to their specific student population, teachers need to be able to effectively address learning challenges, eliminate learning barriers in the environment, establish learning goals, and monitor student progress (Coyne et al., 2006). According to Jimenez, Graf, and Rose (2007), Universal Design for Learning (UDL) is one approach to teaching and learning that can make standards-based curricula more accessible to diverse learners regardless of ability, learning preference, language, or culture. The Center for Applied Specialized Technology's (CAST; 2011) UDL framework provides flexible guidelines for lesson planning across three major principles: "Provide Multiple Means of Representation" (p. 14) for the way information and instructional materials are presented to students, "Multiple Means of Action and Expression" (p. 22) for different ways for

students to interact with learning materials, and “Multiple Means of Engagement” (p. 28) for alternative ways to assess student learning (Lapinski, Gravel, & Rose, 2012).

Although some states have implemented educational policies that support efforts to apply UDL to teacher inservice, instructional materials, and assessments, most of the work that has addressed key issues in UDL has been at the national level (Gordon et al., 2009). The U. S. Department of Education has invested over a decade of research and practice in an effort to make standards-based curricula more accessible, and the National Science Foundation has invested in the development of UDL curricula and assessments (Gordon et al., 2009). The National UDL Task Force was successful in their effort to incorporate UDL preservice training in the Higher Education Opportunity Act of 2008 (HEOA; 2008).

There is currently no reference to UDL in K – 12 federal education policies (Gordon et al., 2009). However, IDEIA (2004) referred to universal design principles in the Assistive Technology Act, emphasizing the use of technologies that maximizes accessibility to the standards-based curriculum and participation for students with disabilities in the inclusive setting and research for the development and administration of assessments and the use of technology. The National Instructional Materials Accessibility Standards (NIMAS) have been included in IDEIA legislation that supports the use of flexible digital instructional resources in classrooms for students with disabilities (NIMAS Development & Technical Assistance Centers, 2008).

Background

Teachers face the challenge of developing curricula that ensure adequate access to the standards-based curriculum in inclusive classrooms. The more prepared teachers are to accommodate the academic needs of a wide range of student ability levels, the more impact they will have on student learning (Coyne et al., 2006). The UDL framework serves as a basis for designing curricula that meet the needs of all learners by personalizing learning through scaffolds and supports and by providing the means to engage in and express learning in different contextual forms (CAST, 2011). Technology- and nontechnology-based instructional materials can be used to provide various ways of acquiring knowledge and information, opportunities to interact with materials, and express knowledge by altering or adjusting the instructional context to meet students' challenges, needs, and learning preferences (CAST, 2011; Rose, Gravel, & Domings, 2012). Student success depends on teachers' ability to effectively communicate standards-based curricula; therefore, it is vital that UDL become a part of inservice training as well as preservice training. UDL considers what may be the exceptions to the norm of student learning by making learning more accessible to the needs of all learners, not just those with disabilities (Myers, Wood, & Pousson, 2008).

Studies that have investigated the effect of UDL lesson plan development training provided during teacher preparation courses showed an increased awareness of student diversity and increased ability to develop universally designed lessons (McGhie-Richmond & Sung, 2013; McGuire-Schwartz & Arndt, 2007; Spooner, Baker, Harris,

Ahlgrim-Delzell, & Browder, 2007; Williams, Evans, & King, 2012). However, no follow-up studies were conducted when these preservice teachers became practicing teachers.

There is the potential for UDL training to improve teachers' attitudes and abilities to meet the needs of diverse learners. CAST conducted UDL professional development case studies on high school general and special education teachers in the inclusive setting (Meo, 2008). After experiencing UDL professional learning and classroom implementation, the teachers viewed universally designed lessons as an effective way to communicate standards-based curricula to diverse student populations (Meo, 2008). Additional studies have also been conducted on UDL lesson plan development inservice training in the inclusive K–12 setting that showed promising results in teachers' ability to develop universally designed lessons for diverse student populations (Baldiris Navarro, Zervas, Fabregat Gesa, & Sampson, 2016; Dalton & Smith, 2012; van Kraayenoord, Waterworth, & Brandy, 2014). With the exception of these studies, there are currently no studies that have specifically addressed UDL inservice training on lesson plan development. This study contributes to current research by examining changes in lesson planning following UDL training for teachers in the K–12 inclusive setting.

Problem Statement

There is a need for teacher training that emphasizes an awareness of diversity in learning and UDL lesson plan development in order to meet the academic needs of diverse learners (Baldiris Navarro et al., 2016). In inclusive classrooms, general education teachers are expected to have a broadened scope of pedagogy in order to

differentiate the challenge level to allow for leverage, engage all learners, and provide alternative modes of assessments (King, Williams, & Warren, 2010). Preservice teachers need to be able to meet the academic needs of all students in their future classrooms (Gargiola & Metcaff, 2010; King et al., 2010). However, recent research indicated that special education and general education preservice teachers did not feel prepared to teach in inclusive classrooms (Gehrke & Cocchiarella, 2012; Gill, Sherman, & Sherman, 2009). They reported that there was not a connection between the knowledge and skills learned in their coursework and the reality observed in inclusive classrooms during their practicum (Gehrke & Cocchiarella, 2012; Gill et al., 2009).

The U.S. Department of Education (2010) awarded grants to universities through their Teacher Quality Enhancement program to have UDL incorporated in special education and general education teacher preparation programs and to ensure that preservice teachers could implement instructional technology tools based on UDL principles and guidelines in the lesson design. Five hundred and eighty instructors from 58 general education teacher preparation programs in 22 states participated in a survey to determine whether UDL was actually being implemented in general education preservice coursework (Vitelli, 2015). Of the 580 instructors surveyed, 350 reported that they were aware of UDL, 353 had basic knowledge about UDL, and 140 taught UDL to their preservice teachers (Vitelli, 2015).

The majority of students with disabilities spend 80% of their time in the inclusive setting (U.S. Department of Education, Office of Special Education Programs, 2012). While IDEA (2004) amendments have included students with disabilities in the general

education setting, general education teachers still feel that they are not prepared to meet the needs of an academically diverse student population. Fuchs (2010) explored some of the problems general education teachers encountered when they taught in inclusive classrooms and found that teachers felt they could not meet the demands and expectations placed upon them. They also felt their postsecondary education programs did not prepare them to teach in inclusive classrooms and that school districts did not provide the adequate training and support needed to meet the demands and responsibilities expected of them (Fuchs, 2010). UDL inservice training has the potential to benefit all teachers, those who have participated in UDL training and those who have not. Although UDL inservice is recommended, it is not being implemented; therefore, there is not enough research to know whether UDL training empowers teachers to develop universally designed lessons.

Purpose Statement

Practicing teachers teach in classrooms with students who have a broad range of academic needs and abilities (Gordon et al., 2009). To meet the academic needs of these students, teachers can use UDL as a framework for lesson plan preparation (Jimenez et al., 2007). Recent studies have shown positive outcomes for teachers, teacher candidates, and students when postsecondary educational coursework and professional development emphasized an awareness of diversity in learning and an application of UDL principles in lesson plan development for unique student populations (Baldiris Navarro et al., 2016; Dalton & Smith, 2012; McGhie-Richmond & Sung, 2013; McGuire-Schwartz & Arndt, 2007; Meo, 2008; Spooner et al., 2007; van Kraayenoord, 2014; Williams et al., 2012).

Unfortunately, “there is a lack of research about how to prepare teachers and teacher candidates in the planning and carrying out of universally designed lessons” (McGuire-Schwartz & Arndt, 2007, p. 129). The purpose of this quantitative study was to examine the changes in teachers’ lesson plans (dependent variable) following UDL professional training (independent variable) in order to help teachers become more aware of diversity in learning and learn how to implement UDL in the lesson design. A predominance of evidence would contribute to the practice of developing universally designed lessons for diverse student populations. The social change objective of this study was to improve the quality of teaching and learning in mixed-ability classrooms.

Research Questions and Hypotheses

This quantitative study investigated the following research questions:

1. Do teachers’ lesson plans demonstrate significant change following UDL professional training?

H₀₁: Teachers’ lesson plans will not demonstrate significant change following UDL professional training.

H_{a1}: Teachers’ lesson plans will demonstrate significant change following UDL professional training.

2. Do teachers’ lesson plans demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training?

H₀2: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training.

H_a2: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training.

3. Do teachers' lesson plans demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training?

H₀3: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training.

H_a3: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training.

4. Do teachers' lesson plans demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training?

H₀4: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training.

H_{a4}: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training.

Nature of the Study

This quasi-experimental study followed a one group repeated measure design to examine changes in teachers' lesson plans following UDL professional training. According to Field (2009), a repeated measure design can show whether changes have occurred in the dependent variable across the various time points of the independent variable. Teachers from five school districts in the state of Mississippi participated in a district-sponsored 10 hour online UDL professional training session that I designed based on the UDL framework. Seventeen teachers were evaluated for their ability to design UDL lessons. An accrediting Continuing Education Units (CEU) agency in the state of Mississippi evaluated the training and determined that one CEU be granted for teachers who participated in the training. The training took place in a Blackboard learning environment. The content was based on cognitive science and neuroscience research, which is the foundation for the UDL framework, the UDL framework (principles and guidelines) for lesson planning, and the essential goals of developing universally designed lessons (CAST, 2011). Participants actively engaged in seven learning modules. In each learning module, participants watched a presentation video; interacted with learning resources for lesson planning; and actively participated in discussions, journal entries, and assignments.

Lesson plans were evaluated at three time points: (a) before training, (b) immediately after training to determine if there were any changes in lesson planning, and (c) 2 months after training to determine if teachers sustained these changes. The Spooner et al. (2007) UDL lesson plan rubric, *The Scoring Rubric on the Three Components of Universal Design for Learning*, was used to evaluate teachers' lesson plans. To provide evidence that the measurement of the dependent variable was accurate, two raters collected inter-rater agreement data within each condition of the study (Kennedy, 2005). A within-subjects MANOVA with repeated measurement was conducted comparing pretreatment and post-treatment scores for each of the four dependent variables (total test score and representation, expression, and engagement scores).

Conceptual Framework

Empirical evidence in cognitive science and educational neuroscience provides an understanding for how the brain connects to instruction and provides a foundation for the design of curricula that meet the developmental needs of all students (Meyer, Rose, & Gordon, 2014; Rose & Meyer, 2002). The three guiding principles of the UDL framework are based on advances in neuroscience and cognitive science (CAST, 2011). The three principles read as follows: "Principle I: Provide Multiple Means of Representation, Principle II: Provide Multiple Means of Action and Expression, and Principle III: Provide Multiple Means of Engagement" (CAST, 2011 pp. 14–28). The instrument used to evaluate teachers' lesson plans in this study, *The Scoring Rubric on the Three Components of UDL* (Spoonier et al., 2007), was designed by a panel of experts to evaluate teachers' lesson plans according to the three UDL principles, and the

treatment for this study was developed to support the implementation of the three guiding principles in the lesson design.

The three brain networks that form the basis of the UDL framework address the fundamental foundations of learning (Meyer et al., 2014; Rose & Meyer, 2002). CAST (2011) states, “The basis for these principles is built on the knowledge that the learning brain is composed of three networks: recognition, strategic, and affective” (p. 11). Each of the three brain networks consist of modules that work simultaneously to organize learning tasks (Meyer et al., 2014; Rose & Meyer, 2002). For example, when students read one area of the brain processes letter and word recognition, another sentence structure, and another comprehension; the pattern of brain activity corresponds with the learning task and varies from individual to individual (Rose & Meyer, 2002). Through practice and exposure to the different ways content is presented, practiced, and assessed, changes occur at the behavioral and neural level of the brain (Rose & Meyer, 2002).

Neuroscience research on individual learning differences has established the need to design a more flexible and diversified approach to teaching and learning that accommodate the different ways learners perceive information, process information, and express what they know (Meyer & Rose, 2005; Rose & Dalton, 2006). The UDL framework is a guide for developing curricula that accommodates these learning differences (CAST, 2011). Since learners vary in the way they process learning and manage the learning environment, understanding the function of brain networks helps teachers better understand the strengths and areas of need of each individual learner

(Meyer & Rose, 2005; Rose & Dalton, 2006). In the following paragraphs, I provide a detailed explanation of the three UDL principles.

“UDL Principle I: Provide Multiple Means of Representation” helps teachers develop curricula that support the unique differences that exist in recognition brain network functions (CAST, 2011, p. 14). According to CAST (2011) “Learning and transfer occur when multiple representations (i.e., graphics and text) are implemented in the learning environment that allows students to make connections within and between concepts” (p. 5). Brain-imaging technology has shown that different areas of the brain manage different recognition functions (Rose & Dalton, 2006; Rose & Meyer, 2002). For example, students learn about an object’s shape, color, motion, and orientation using different parts of their recognition networks (Rose & Meyer, 2002). The brain processes words in different areas when words are presented in speech as opposed to text (Rose & Meyer, 2002). Consideration of the different ways learners perceive and comprehend information allows for optimal learning to occur (Meyer et al., 2014; Rose & Dalton, 2006; Rose & Meyer, 2002).

“UDL Principle II: Provide Multiple Means of Action and Expression” is based on strategic brain network functions (CAST, 2011, p. 22). Strategic networks in the brain allow for planning, task performance, and the organization and expression of ideas (Meyer et al., 2014; Rose & Meyer, 2002). According to CAST (2011), “Learners differ in the way they navigate learning and express what they know” (p. 5). Expression involves the use of metacognitive strategies and practice (CAST, 2011). Learners not only differ in how they express what they have learned; they also differ in their

development of strategy use (Meyer et al., 2014; Rose & Meyer, 2002). The UDL framework supports the development of curricula that provide different ways to practice skills, develop strategies that foster independence, and demonstrate what has been learned (CAST, 2011).

“UDL Principle III: Provide Multiple Means of Engagement” is based on affective brain network functions (CAST, 2011, p. 28). Affective networks address the motivation to learn, learners’ interest, and the ways that they are challenged (Meyer et al., 2014; Rose & Meyer, 2002). Learners also differ in the way they become motivated and stay engaged in learning (CAST, 2011). The UDL framework supports motivational differences by recommending that teachers develop curricula that offer choices of learning materials to recruit interest and adjust the level of challenge and support to sustain interest and allow for leverage (CAST, 2011).

Operational Definitions

Cognitive science: Cognitive science is based on recent advances in the fields of cognition, memory, learning, and neuroscience that have contributed to our current understanding of cognitive functions which lead to improvements in teaching and learning (Bruning, Schaw, & Norby, 2011; Bryck & Fisher, 2012). According to Thagard (2012), “The central hypothesis of cognitive science is that cognition is best understood in terms of mental representations in the mind and conceptual procedures that operate those images” (p. 10). Brain networks are useful for understanding psychological processes that include mental imagery, decision making, explanation selection, and language comprehension (Thagard, 2012).

Curricula: Curricula are teacher lesson plans that consist of four essential components: learning goals, formative and summative assessments that guide instruction, instructional approaches, and teaching and learning methods or instructional approaches and procedures teachers use to enhance the learning process (Hall, Meyer, & Rose, 2012). Teachers design UDL curricula for their unique student population to strengthen short-term learning goals that progressively move students toward long-term goal mastery (CAST, 2011; Hall et al., 2012).

Educational neuroscience: Educational neuroscience is based on recent advances in neuroscience that have contributed to the understanding of brain function and development (Bryck & Fisher, 2012). These findings have indicated that learning occurs physiologically at the neuron level in the brain. The brain looks for similarities in the things humans experience and maps patterns and events that occur frequently (Miller & Tallal, 2006). Those experiences make up our sensory input that travels to the brain through our five senses. The brain's neurons then code what is valuable and makes predictions of what will occur (Miller & Tallal, 2006). Neuroplasticity is the process in which the brain changes through meaningful learning experiences (Bryck & Fisher, 2012).

Scaffolds: Scaffolds are implemented in universally designed lessons to support learning and provide greater access to the standards-based curriculum (CAST, 2011). Under scaffolding conditions, teachers and students actively participate in a task that exceeds students' current understanding of the task (Rappolt-Schlichtmann, Daley, & Rose, 2012). The teacher first models the task, and then provides student support

according to their needs. Teachers continuously assess students' understanding throughout the process and provide support that is faded out as students demonstrate a clear understanding and can perform the task independently (Rappolt-Schlichtmann et al., 2012).

Standards-based curricula: The standards-based curricula are long-term learning goals or learning outcomes based on K–12 state content standards that guide curricula planning (Hall et al., 2012). The UDL framework was designed to guide teachers in developing lesson plans that support standards-based curricula teaching and learning (CAST, 2011).

Universal Design for Learning (UDL): The following is a definition of UDL provided by the HEOA of 2008:

The term, universal design for learning, means a scientifically valid framework for guiding educational practice that: (a) provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and (b) reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient. [Pub. L., No. 110-315, § 103(a)(24)]

Assumptions

Two assumptions were made in the research design for this study. One assumption was that the training would prepare teachers to successfully develop and

sustain UDL implementation in the lesson design. Teachers may need additional training and coaching to develop UDL lessons. The second assumption was that lesson plans evaluated by raters are performed accurately and without bias. The following inter-rater agreement procedures were taken to ensure the validity of measurement outcomes: (a) I trained the inter-rater on how to accurately score points according to the rubric criteria, including the three UDL principles and each of their guidelines; and (b) reliability checks were conducted throughout the course of data collection to identify when inter-rater reliability began to decline due to rater drift.

Scope and Delimitations

This study was limited to the teacher population sample used in the study when addressing the need for teacher training that emphasizes an awareness of diversity in learning and UDL lesson plan development. Any results from the study can only be generalizable to schools that employ teachers with similar backgrounds. The generalizability of the results from raters was limited to the measurement tool. Therefore, research with the use of other measurement tools for UDL lesson plan evaluation should be noted for potential differences with any comparison.

Limitations

A treatment effect is demonstrated in a repeated measure design by discontinuity in the pattern of pretreatment and post-treatment responses (Johnson & Christensen, 2007). A repeated measure design can show whether changes have occurred in the dependent variable across the various time points of the independent variable (Field, 2009). According to Johnson and Christensen (2007), confounding variables do not affect

the validity of the study design because they are present and do not change in both pretreatment and post-treatment responses. They also explained that the confounding variable that can be a threat to this design's internal validity is history. History is a plausible explanation if an event occurs at the same time the intervention is administered (Johnson & Christensen, 2007). The targeted population included teachers who did not participate in any other UDL training sessions throughout the course of the study.

Johnson and Christensen (2007) also noted three other factors that pose a threat to the internal validity of this design: (a) testing, (b) instrumentation, and (c) interaction of selection and treatment. The following measures were taken to compensate for the limitations of this study.

- A reliable instrument that was used in a previous study was used to evaluate teachers' lesson plans.
- The Spooner et al. (2007) UDL lesson plan scoring rubric was developed by a panel of experts.
- Two inter-raters used the instrument to evaluate teachers' lesson plans.
- Teachers with various years of teaching experience, degrees, and certification status participated to compensate for interaction of selection.
- The procedural fidelity of the treatment, UDL professional training, was measured by a district-appointed observer using an observer checklist.

Another limitation of this study was the use of nonprobability sampling. Frankfort-Nachmias and Nachmias (2008) point out, "Accurate estimates of population parameters can only be calculated with probability samples" (p. 167). However, probability sampling

may not be appropriate for some educational studies. The authors also mention, “Social scientists often use nonprobability sampling, such as convenience sampling, in their research when it becomes more economically feasible, a population cannot be defined, or when a list of the sampling population is not available” (p. 168). McMillan and Schumacher (2006) argued that many experimental and quasi-experimental studies do not employ probability samples, because they are not required or appropriate. Instead of using random sampling, educational researchers use subjects who are accessible or who may represent certain types of characteristics that can be generalized to other populations that are similar (McMillan & Schumacher, 2006).

A convenience sample was used for the teacher population in this study. Creswell (2009) points out, “In many quantitative experiments, only a convenience sample is possible because the researcher must use naturally formed groups” (p. 148). McMillan and Schumacher (2006) described the strengths and limitations for using a convenience sample: the sampling strategy cannot precisely be generalized to any type of population and, the generality of the findings are limited to the characteristics of the subjects. Most schools employ teachers with a broad range of characteristics, and schools with similar teacher demographics will be able to identify with the characteristics of the population in this study.

In this study, a valid instrument was used to evaluate teachers’ lesson plans. The content validity of the rubric used in the Spooner et al. (2007) study “was measured by an expert panel composed of a special education professor with expertise in curriculum adaptation, a math education professor who was experienced in inclusive practices, and a

research associate with expertise in research on literacy” (p. 111). The researchers designed the rubric, and a panel of experts determined whether the instrument accurately represented the three UDL principles (Spooner et al., 2007).

For the inter-rater agreement of this study, steps were taken to ensure the validity of the measurement outcomes. Kimberlin and Winterstein (2008) explain, “Inter-rater reliability is strengthened when raters are trained on how to apply explicit criteria; therefore, raters must be trained on how to make a decision that an event has occurred or how to determine which point on the scale measuring strength should be applied” (p. 3). For this study, the inter-rater was trained on how to determine points according to the scoring rubric criteria, measuring the strength of the lesson plan according to the three UDL principles. Kimberlin and Winterstein (2008) also noted that rater drift may occur when raters begin to change the way they apply the scoring criteria by becoming too lenient or stringent. As recommended by those authors, reliability checks were conducted throughout this study’s data collection process to identify when inter-rater reliability had begun to decline due to rater drift.

Significance of the Study

With a growing population of an academically and culturally diverse student population in classrooms across the nation, it is vital that researchers make a contribution to the educational community that promotes UDL teacher training and implementation in classrooms to accommodate diversity in learning. Policy makers and practitioners look to learning science research to improve the quality of education (National Research Council, 2002). However, most learning sciences research does not address the challenges that K–

12 teachers face today (Rappolt-Schlichtmann et al., 2012). Teachers need to learn how to eliminate barriers in the general education learning environment to accommodate academic diversity and be able to develop proactive lessons to teach in inclusive classrooms (Gargiola & Metcaff, 2010; King et al., 2010). To build a connection between learning science research and practice, success will depend on building communications and relationships. According to Samuels (2009), transdisciplinary efforts have not progressed in the past due to philosophical, methodological, and epistemological differences between research and practice. The UDL framework is based on learning differences and the current understanding of how people learn and serves as the foundation for the connection between learning science research and practice (Rappolt-Schlichtmann et al., 2012).

An educational system that considers the cognitive and social-emotional needs of all learners contributes to the nation's society and economy; students who have not been academically successful in traditional classrooms lack the basic skills and background knowledge needed to fully master the standards-based curriculum. The UDL framework is a proactive approach to learning and lesson design (Meo, 2008). It helps teachers identify barriers that exist between students' discrepancies and learning and guides them in the implementation of accommodations, modifications, faded scaffolds, and/or supports for their specific student population (Meo, 2008).

There is a need for teacher training that emphasizes an awareness of diversity in learning and UDL lesson plan development in order to accommodate the diverse academic needs that exist in every classroom (Baldiris Navarro et al., 2016). Each

learning context has unique differences that contribute to the understanding of how to prepare teachers to meet the challenges they face. Although previous research has studied the importance of UDL, there is less research examining how to support research-to-practice.

The results of this study provide insight into teaching and learning processes that accommodate the academic needs of diverse student populations. The tenet of UDL requires a consideration of the needs of all learners in standards-based educational settings by eliminating barriers in the environment that allow greater access to the curriculum (CAST, 2011). The goal of this study was to support teachers in their efforts to accommodate the academic needs of diverse student populations in K–12 education. This study has the potential to improve the quality of teaching and learning in mixed-ability classrooms.

Summary of the Introduction for the Study

In this chapter, I introduced the UDL framework and discussed the purpose and problem statement. The purpose of this quantitative study was to examine the changes in lesson planning following UDL professional training. In the problem statement, I provided evidence that a limited number of studies have been conducted on UDL lesson plan development inservice training. I also described the UDL framework, which guided the study and focuses on the design of UDL lesson plans that allowed diverse student populations greater access to the standards-based curriculum. In Chapter 2, I provide research that explicates the theoretical framework and discusses UDL lesson plan development training research.

Chapter 2: Literature Review

Introduction

Recent advances in neuroscience have contributed to the understanding of brain function and development (Bryck & Fisher, 2012). According to CAST (2011), “Learning is distributed across three interconnected networks of the brain: recognition networks, strategic networks, and affective networks” (p. 11). Brain-imaging devices have shown that learning differences are much broader than previously thought; there are individual differences in brain network functions. (Meyer & Rose, 2005; Rose & Dalton, 2006). Individuals differ in their strengths, areas of need, and preference – affecting the way they learn, engage, and respond (Meyer et al., 2014). Recognition networks enable students to identify and interpret patterns through their senses (Rose & Meyer, 2002). Students vary in the way they recognize information, build knowledge, and connect new information to prior knowledge (Meyer et al., 2014; Rose & Meyer, 2002). Strategic processes involve identifying, planning, and carrying out an action (Rose & Meyer, 2002). Students also vary in the way they use their strategic network to internally monitor cognitive and physical patterns that guide their thoughts, actions, and skills (Meyer et al., 2014; Rose & Meyer, 2002). Affective networks are distributed across many modules within the core of the brain, which is why students exhibit motivational differences for learning (Rose & Meyer, 2002). These differences also depend on the challenge level of the learning experience and student interest (Meyer et al., 2014; Rose & Meyer, 2002).

Educational neuroscience research has made a connection between brain science research and practical educational research (Campbell, Cimen, & Handscomb, 2009; Nes

& Lang, 2007). The research is based on cognitive learning theory and neuroscience theory in order to form testable predictions that can be made to optimize learning in educational contexts (Campbell, Cimen, & Handscomb, 2009). The aim is to develop the abilities of students by building an understanding of the possibilities and qualities students exhibit as they engage in learning activities, how these abilities and qualities may be enhanced, and in what ways they connect to language (Campbell et al., 2009; Nes & Lang, 2007).

Cognitive science research provides a strong theoretical foundation for the design of instructional frameworks that are aligned with the curriculum and learning environment. Turner (2011) reviewed 30 years of learning science research in an effort to support primary and middle school students by composing an instructional guide for teachers based on empirical evidence. Evidence-based, student-centered instructional strategies that have been effective in engaging all learners include focusing on learning essentials and why they are essential, the use of students' present knowledge to guide instruction, providing numerous opportunities to learn the same concepts in different ways, establishing individual learning goals, encouraging intrinsic motivation, and developing metacognitive and strategic thinking skills (Turner, 2011).

In the literature review, I present significant peer-reviewed literature on UDL professional learning and lesson plan development. The UDL framework is the foundation of the intervention and data analysis instrument used in this study. Therefore, I also present literature for each of the nine guidelines of the UDL framework to show

how UDL teaching and learning methods and materials significantly affect student learning in the K–12 educational setting, how UDL curricula are developed, and why the appropriate development of UDL curricula are vital to learning in mixed-ability classrooms.

Literature Search

I used the following databases to retrieve peer-reviewed literature pertaining to UDL principles and guidelines and UDL professional learning and lesson plan development: Google Scholar, ERIC, ProQuest Central, Academic Search Complete, and Educational Research Complete, all accessed through the Walden University Library online. In searching for literature, the following keywords were used individually and in various combinations: *universal design, learning, lesson plan development, visual representations, explicit instruction, instruction, scaffolds, multimedia, peer-mediated, curriculum-based measurement, self-regulation, choices, motivation, assistive technology, problem solving, autonomy, and interest*. In addition, I used the following organization's professional websites to retrieve peer-reviewed literature, publications, and books: Center for Applied Specialized Technology and National Center on Universal Design for Learning. The search was limited to literature published in the last 5 years; however, there is a limited amount of current research on how UDL teaching and learning methods and materials impact learning and UDL professional learning and lesson plan development. It was necessary to include older peer-reviewed literature as well.

UDL: A Scientifically Informed Framework for Lesson Planning

The three UDL principles are based on advances in neuroscience learner variability and the three primary brain networks that pertain to learning, and current cognitive science research (CAST, 2011). Principle I and Guidelines 1, 2, and 3 of the UDL framework support learning differences in recognition brain network functions (CAST, 2011; Lapinski et al., 2012). Principle II and Guidelines 4, 5, and 6 of the UDL framework support strategic brain network functions. Principle III and Guidelines 7, 8, and 9 of the UDL framework support affective brain network (CAST, 2011; Lapinski et al., 2012).

Principle I

Principle I and Guidelines 1, 2, and 3 of the UDL framework emphasize the need to consider the different ways in which students perceive and understand information when developing curricula (CAST, 2011; Lapinski et al., 2012). For some students, the inflexibility of printed text does not provide full access to information; for others, information that is only presented in audio format forms a barrier to learning (CAST, 2011; Lapinski et al., 2012). In addition, each student brings their own set of experiences and background knowledge to the classroom that influence the way they comprehend information (Lapinski et al., 2012). Therefore, curricula should be flexible enough to accommodate the diverse learning needs of a given student population (Lapinski et al., 2012).

Guideline 1

When Guideline 1 is implemented in the lesson design, consideration is given for the different ways students perceive and understand content in order to allow all students access to the curriculum (CAST, 2011; Lapinski et al., 2012). Consideration is also given to their current level of knowledge, skills, and abilities (CAST, 2011; Lapinski et al., 2012). For example, when information is only presented in text format, students with visual impairments and students with reading difficulties do not have full access to the curriculum; or when information is only presented through lecture students with hearing impairments, processing, and, memory difficulties do not have full access (CAST, 2011). Explanations are also needed for visual information such as graphs that are complex and difficult to interpret, or when using concrete objects and models to communicate the relationship within and between concepts (CAST, 2011). A digital medium, such as Smartboards or interactive graphic organizers, can provide easy access to the background knowledge and vocabulary needed for comprehension, and text can easily be enlarged or highlighted (CAST, 2011; Lapinski et al., 2012).

Guideline 1 Significance for Learning

When teachers have a better understanding of the depth of learner variability and use a scientifically-informed framework for curricula development, they are better prepared to meet the academic needs of a diverse student population. The following studies have shown that students improved their ability to generate explanations and comprehend learning goals when developmental and ability appropriate options for perception were provided that included audio and text, or modeling using concrete and

pictorial representations with written explanations. Boyle, Rosenburg, Connelly, Washburn, Brickhoff, and Banerjee (2003) found that special education middle school students who lacked the basic reading skills needed to comprehend content area secondary education text performed significantly higher on content area assessments when they engaged in instruction that included an audio version of the text prior to the assessment. Butler, Miller, Crehan, Babbvitt, and Pierce (2003) discovered that middle school students with learning disabilities improved their ability to understand mathematical processes when teachers were trained on how to effectively communicate procedural content knowledge using concrete and pictorial representations during scaffold instruction that included modeling, cues, and written explanations for guided and independent practice and problem solving activities. The ability to apply complex reasoning when making scientific predictions significantly improved for elementary school students when teachers first modeled and explained strategies for similar experimentation to support information processing (Rappolt-Schlichmann, Tenenbaum, Koepke, & Fisher, 2007). Merkt, Weigand, Heir, and Schwan (2011) found that videos were better suited for acquiring declarative content knowledge for high school students, because videos allowed students to control information processing and self-regulate the pace of learning according to their cognitive needs.

A modality effect occurs when instructional materials presented in visual and auditory format have a stronger impact on learning than instructional materials that are only presented in visual format (Mayer, 2009). The presentation of instructional materials is vital to “working memory load and the ability to transfer information from short term

memory to long term memory” (Leahy & Sweller, 2011, p. 944). However, some content may limit or reduce the modality effect due to working memory processing limitations (Leahy & Sweller, 2011). Recent studies have found that a modality effect mostly occurred when instruction was designed to highlight key concepts to reduce cognitive overload and effectively integrate developmental and ability-appropriate materials that supported the learning process (Leahy & Sweller, 2011; Yung & Paas, 2015).

Guideline 2

Guideline 2 considers the different ways learners process language and visual representations (CAST, 2011; Lapinski et al, 2012). One form of representation may not provide access for all students (CAST, 2011; Lapinski et al, 2012). For example, a written definition of a vocabulary word may clarify meaning for some students, but confuse others (CAST, 2011). A pictorial representation may provide meaning for some students, but not other students from a different culture or background (CAST, 2011). Therefore, it is important to preteach vocabulary, provide multimedia dictionaries with translations and visuals (i.e., pictorial representations and videos), and concrete representations (CAST, 2011; Lapinski et al, 2012).

Guideline 2 Significance for Learning

Some students may refrain from engaging in learning tasks across curricula or behave inappropriately because they struggle to read (Gordon, Proctor, & Dalton, 2012; Meyer et al., 2014; Rose & Dalton, 2006). When textbooks are the primary resource for student engagement, it becomes a barrier to learning for students who have difficulty with decoding, word recognition, fluency, and comprehension (Gordon et al., 2012). UDL

supports “access and learning” (Rose & Dalton, 2006, p. 143) within Vygotsky’s (1978) zone of proximal development (ZPD) for scaffold instruction. New digital reading instructional environments have been developed that enhance learning for all students and accommodate areas of need for students who need support for goal attainment (Gordon et al., 2012; Rose & Dalton, 2006).

Proctor, Dalton, and Grisham (2007) investigated the effect a technology-based approach to reading, the Universal Literacy Environment (ULE), had on primary school students’ vocabulary and reading comprehension. ULE scaffolding features include coaching that provides support for reading comprehension strategy use, hyperlink vocabulary for word meaning, examples of how words are used in sentences, illustrations, and text-to-speech that allows struggling readers to focus on reading comprehension instead of decoding (Proctor et al.). Results of the pretest/post-test reading assessment showed that hyperlinks were positively associated with vocabulary gains and reading comprehension gains were significantly associated with ULE strategy support (Proctor et al., 2007).

Multimedia learning environments can be designed to support recognition, strategic, and affective brain network learning differences through a medium that can provide multiple forms of visualization, support for metacognition, and sustain student interest (Dalton & Meyer, 2006). They can also be designed to support conceptual learning by implementing accessible support to the background knowledge and skills needed to fully engage in learning goal objectives and by emphasizing key concepts and relationships to reduce cognitive overload – freeing the working brain for higher order

thinking. Twyman and Tindal (2006) examined the effect a conceptually-formatted digital textbook had on high school science students' reading comprehension and problem solving performance. Students participating in the Twyman and Tindal (2006) study had access to a summary of each chapter, a list of concepts, a graphic organizer showing the important aspects of the concepts, and a leveled reader for struggling readers. Unlike the ULE multimedia environment used in the Proctor et al. (2007) study, there was no significant difference between students who used the digital text when compared to students who used the printed text for comprehension. The conceptually-formatted digital textbook in the Twyman and Tindal (2006) study did not provide the appropriate strategic support to improve comprehension (i.e., reading comprehension strategies used across the curriculum – predicting, summarizing, compare/contrast, making inferences, drawing conclusions). However, students who used the digital textbook in the study out performed students who used the printed textbook on the response essay that measure problem solving (Twyman & Tindal, 2006).

Multimedia have the potential to enhance learning for all students; however, research has shown promising results for students with learning disabilities when strategic supports were implemented in the instructional design. Bottage, Rueda, Serlin, Hung, and Kwon (2007) investigated the effect a scaffold multimedia learning environment had on middle school students' ability to solve real world mathematical problems, and then apply what they learned to real-world mathematical problems. Both students with learning disabilities and students without learning disabilities who participated benefited from the experience (Bottage et al.). Students with learning

disabilities scored lower on pretest scores, but there was no significant difference between the two groups on post-test scores (Bottage et al., 2007).

Students with learning disabilities can become easily discouraged when instruction in the general education setting does not accommodate their academic needs (Gordon et al., 2012; Pisha & Stahl, 2006). A multimedia learning environment based on UDL principles can improve learning for students with learning disabilities who need additional supports for access and metacognition (Meyer et al., 2014). Multimedia learning environments provide access to multiple forms of representation, and assistive technology (AT) support is easily available for written text to help the learner develop an understanding of vocabulary and key concepts (Austin, 2009). To accurately assess the academic performance of students with disabilities, they need to be exposed to a learning environment that provides explicit instruction and guided practice with faded scaffolds to facilitate learning (Kennedy, Deshler, & Lloyd, 2013; Kennedy, Lloyd, Cole, & Ely, 2012).

Current research on multimedia learning has shown that these environments have a stronger impact on learning when UDL principles and guidelines were implemented in the design and key curriculum concepts were highlighted to reduce cognitive overload (Leahy & Sweller, 2011; Yung & Paas, 2015). Kennedy, Newman-Thomas, Meyer, Alves, and Lloyd (2014) also investigated the effect of multimedia instruction based on UDL and cognitive overload reduction. Only key content were addressed to reduce cognitive overload and images and text consistent with UDL principles of representation and engagement were embedded in the learning modules (Kennedy et al., 2014). High

school students with and without learning disabilities who participated in the Kennedy et al. (2014) study were randomly assigned to alternating treatments that were sequentially administered: (a) multimedia instruction, and (b) traditional instruction. Students made significant progress on weekly curriculum-based assessments and scored significantly higher on post-tests when they engaged in the multimedia learning environment (Kennedy et al., 2014).

Additional research on the effectiveness of multimedia learning environments based on UDL and cognitive overload reduction has also produced positive learning outcomes for students with and without learning disabilities. Korat, Levin, Ben-Shabt, Shneur, and Bokovza (2014) investigated how an electronic dictionary embedded with an e-book impacted elementary school students' vocabulary comprehension and spelling. Students in the experimental group participated in four different treatment conditions: (a) visuals without the printed words, (b) videos without the printed words, (c) visuals with the printed words, and (d) videos with the printed words. Post-test vocabulary and spelling assessment scores indicated that all four groups improved in vocabulary and spelling; however, students benefited the most from the exposure to visuals with the printed word and highlighted text for spelling, producing a modality effect and reducing cognitive load (Korat et al., 2014).

Guideline 3

Guideline 3 stresses the importance of actively engaging students in the learning process to develop their ability to transform information into usable knowledge for decision-making (CAST, 2011). CAST (2011) explains, "The ability to transform

information into usable knowledge depends on information processing skills – selective attending, integrating new information with prior knowledge, strategic categorization, and active memorization” (p. 19). Students differ in their ability to process information, connect prior knowledge to new information, and in how much prior knowledge they have acquired through previous learning (CAST, 2011; Lapinski et al., 2012). It is vital to develop curricula that activate prior knowledge and embed faded scaffolds and the appropriate supports for information processing (CAST, 2011; Lapinski et al., 2012).

Guideline 3 Significance for Learning

Traditional teaching and learning methods and materials are based on a Piagetian approach to learning where students are required to develop a set of skills before engaging in more complex learning tasks. For example, reading instruction for students with cognitive disabilities has traditionally focused on the development of basic reading skills (decoding, vocabulary, and word recognition) in isolation with little focus on reading comprehension (Coyne, Picha, Dalton, Zeph, & Smith, 2010). A UDL approach to teaching and learning is goal-oriented (Vue & Hall, 2012). Based on Vygotsky’s (1978) ZPD, strengths and areas of need are first identified for a given student population to establish learning goals and to develop curricula that ensure all students have access to curriculum standards (Jackson, Harper, & Jackson, 2005). Teachers can then remove learning barriers and fully engage students in more complex learning tasks with the appropriate explicit instruction, faded scaffolds, ATs, and supply and/or activate prior knowledge as needed for goal attainment (Jackson et al., 2005).

Knowledge acquisition is developmental, not a sudden shift from one stage of development to the next, and knowledge acquisition differs from content area to content area (Smolkin & Donovan, 2001). Fluency in basic reading, writing, and mathematical skills does not mean that students will be able to comprehend the challenging text they will encounter across content areas, or that they will automatically be able to apply number sense to mathematical word problems, or that good spellers will make good writers. A more comprehensive approach to learning is needed that is repeated with each cycle of development (Smolkin & Donovan, 2001). For example, “A comprehensive reading acquisition curriculum would ensure that growth in concepts and vocabulary would occur simultaneously with growth in decoding” (p. 13). Children in elementary school have the capabilities to engage in comprehensive reading instruction (Smolkin & Donovan, 2001).

Experts have the ability to plan a task, are more aware of patterns that connect meaningful information, can generate explanations and arguments, and understand content knowledge (Bradsford, Brown, & Cocking, 2000). To develop expert learners, students need to see the connection within concepts and between concepts (CAST, 2011). Traditional curricula isolate factual and declarative knowledge from procedural knowledge that build a conceptual understanding of content instead of repeating the cycle at each level of learning (Michaelsen & Sweet, 2008). Thus, students cannot see the relevance of learning, because they have to make huge inferences about how the knowledge is applied (Michaelsen & Sweet, 2008). For example, students can learn writing mechanics as they apply those skills to daily writing activities across the

curriculum. Students need to be exposed to a variety of learning experiences for the same concepts to develop the knowledge and skills needed to master content standards (Murray & Brookover, 2012).

Traditional curricula rarely engage students in real-world problem-solving scenario learning experiences (Jonassen, 2003). To solve real-world problems, students need to understand related content knowledge in order to filter relevant information from irrelevant information pertaining to the given scenario and to fill in missing information that is needed to solve the problem (Jonassen, 2003). They also need structural knowledge to develop expertise (Bradsford et al., 2000). Unlike novice learners, experts try to develop a conceptual understanding of the problem (Bradsford et al., 2000). Novice learners need scaffolds and supports to engage in higher order thinking and to develop their metacognitive skills and a conceptual understanding of complex problems (Bradsford et al., 2000). Research has shown that when scaffold explicit instruction was embedded in instruction and background knowledge was provided to support an understanding of real-world mathematical problem solving scenarios, elementary school students significantly improved their ability to solve complex real-world mathematical problems (Fuchs et al., 2006).

Coyne et al. (2010) developed and investigated the effect a comprehensive reading instruction program had on elementary school students with cognitive disabilities. The digital comprehensive reading program in the Coyne et al. (2010) study contained scaffold ebooks, embedded supports for perception and metacognition, and supplied background knowledge to engage students with cognitive disabilities in a more

comprehensive approach to reading instructions that addressed all five of the reading criteria addressed by the National Reading Panel (NRP; 2000): phonemic awareness, phonics, vocabulary, fluency, and comprehension. Teachers participating in the study (experimental and control groups) engaged in a one-day workshop that addressed the five criteria and reading strategies for students with cognitive disabilities (Coyne et al., 2010). Teachers in the experimental group were trained on how to use the comprehensive reading instruction software. The results indicated that a more comprehensive approach to reading instruction significantly improved students' reading and comprehension when compared to traditional instruction (Coyne et al., 2010).

More hypertext systems (digital libraries) are being used in science classrooms to support reading and scientific inquiry (Putambekar & Goldstein, 2007). However, the flexibility of hypertext systems pose navigational challenges for novice learners. A hypertext system can be customized to accommodate the specific academic needs of a given student population by providing navigational cues and prerequisite links for novice learners (Eklund, Brusilouski, & Schwarz, 1998).

Putambekar and Goldstein (2007) developed a hypertext system with science middle school teachers that provided a visual map of the conceptual structure of the learning content. The researchers then explored how the system affected students' comprehension of the system. Students participating in the Putambekar and Goldstein study were assigned to one of two groups: the concept mapping hypertext system or an online hypertext of the learning content. When a concept was selected in the conceptual structured hypertext system, a description of the concept appeared with a map showing

the interrelatedness within and between concepts instead of providing information in an organized, sequential fashion with the option to use a glossary like the traditional online hypertext system (Putambekar and Goldstein). The concept mapping system also provided links to supply background knowledge if needed (Putambekar and Goldstein). Traditionally structured hypertexts are limited to the information available in the text, and do not provide multiple forms of representation to accommodate learner variability (Putambekar and Goldstein). Findings indicated that students who were exposed to the concept mapping version of the hypertext system developed a deeper understanding of the learning content and better understanding of the interrelatedness of science concepts and principles (Putambekar & Goldstein, 2007).

Marino et al. (2014) examined the academic performance of middle school students with learning disabilities in inclusive science general education classrooms over the course of 1 year. For some of the science units, students engaged in video games with scaffold explicit instruction to develop an in-depth understanding of essential learning concepts and to stimulate scientific inquiry and transfer, and students were also offered an alternative printed text with illustrations that was aligned with the general education curriculum (Marino et al., 2014). The results showed an increase in student engagement when students used learning materials closely aligned with UDL principles; students with learning disabilities made improvements on the unit tests, and there was no significant difference on their unit test scores when compared to their peers without disabilities (Marino et al., 2014). However, some prepackaged educational software, like video games, may not be specifically aligned with the standards-based curricula; therefore, it is

difficult to measure whether they contribute to student learning (Marino, Basham, & Beecher, 2011).

Principle I Significance for Teaching and Learning

When UDL lesson plan development was incorporated in teacher education programs, general education preservice teachers showed beginning signs of learning how to develop proactive universally designed lessons to accommodate academic diversity and increased their self-efficacy for teaching in inclusive classrooms. A self-assessment tool was administered before and after treatment to investigate the impact UDL lesson plan training had on preservice teachers' perceptions of their ability to develop universally designed lessons (Williams et al., 2012). Preservice teachers participating in the Williams et al. study rated themselves as competent in identifying students' learning deficiencies, designing differentiated instruction lessons, implementing instructional strategies that match the academic needs of the learner, and incorporating technology in the curriculum. Although some of the preservice teachers participating in the Williams et al. study reported feeling less confident in their ability to design UDL lessons that incorporated multiple forms of engagement and expression, they became more familiar with UDL principles. Before participating in the course, they did not include more than one form of representation, engagement, and expression; after participating in the course, most included two forms for each of the UDL principles (Williams et al., 2012). As practicing teachers, they will need inservice training to fully develop their ability to accommodate learner variability.

In the Spooner et al. (2007) study, “Preservice teachers enrolled in special education courses were given a case study of a student with a severe disability, and participants in general education courses were given a case study of a student with a mild disability” (p. 110). This approach is appropriate because most students with severe disabilities receive services in the confined special education classroom and students with mild to moderate disabilities receive services in the inclusive setting. Study participants in the Spooner et al. (2007) study were asked to design a UDL lesson for one standards-based curriculum goal using a standardized lesson plan template, and the researchers designed a scoring rubric based on the three UDL principles to evaluate teachers’ lesson plans in both groups before and after the intervention was administered to the experimental group. The results of the experimental group showed a significant difference for representation when compared to the control group (Spooner et al., 2007). Baldiris Navarro et al. (2016) conducted a study that evaluated teachers’ lesson plans according to the Spooner et al. (2007) lesson plan scoring rubric following UDL professional development training designed to facilitate teachers to create digital-supported universally designed lessons for the inclusive setting. In the Baldiris Navarro et al. (2016) study, teachers from each of the three school districts demonstrated a considerable amount of growth for representation in the lesson design: District 1 (pretest $M = 1.06$; post-test $M = 2.88$), District 2 (pretest $M = 1.47$; post-test $M = 2.94$), and District 3 (pretest $M = 1.29$; post-test $M = 2.86$).

Both preservice and inservice teachers identified learning barriers that students experienced and applied UDL principles and guidelines to existing lesson plans following

UDL lesson plan development training in the McGhie-Richmond and Sung (2013) study. Preservice teachers made more revisions for Principle I – Guideline 3 that included activating prior knowledge, highlighting key concepts, and visually supporting information processing, and less for Principle I – Guideline 2 that included preteaching vocabulary, making connections within and between concepts using visual representations, and illustrating through multimedia than practicing teachers (McGhie-Richmond & Sung, 2013). Twelve percent of the resources teachers accessed for instruction using an online scaffold UDL lesson plan tool in the Dalton and Smith (2012) study were in one form of representation (text or visual), 39% accessed text and visual resources, and 50% accessed multiple means of representation that included podcasts, interactive video games, videos, pictures, and text (Dalton & Smith, 2012). Having access to digital instructional tools in the online environment made it easier for teachers to integrate forms of representation in the lesson design.

Unlike traditional curricula that have to be modified after lesson plans have been created, the UDL framework guides teachers as they create one universally designed lesson for their specific student population that is based on observation and interaction with students in the educational environment and valid assessment data (Hall et al., 2012). When UDL inservice was provided for practicing teachers, they were able to see that learning barriers existed in traditional teaching and learning methods and materials and developed ways to design proactive lessons for their students (Meo, 2008). Teachers participating in the CAST case studies found that students gained a better understanding of content knowledge when they used universally designed methods and materials (Meo,

2008). Participants in the study engaged students in brainstorming activities using inspirational software, concept mapping to activate prior knowledge, and vocabulary instruction to support comprehension (Meo, 2008). Teachers in the van Kraaynoord et al. (2014) study discovered that when Principle I guidelines were implemented in the lesson design, no further revisions needed to be made to lesson plans.

Principle II

Principle II and Guidelines 4, 5, and 6 of the UDL framework emphasize the need to consider the different ways students approach the learning task and demonstrate what they have learned (CAST, 2011). There are differences in executive function capabilities or in the way students strategize and organize, and they also differ in the way they communicate what they have learned. (CAST, 2011; Lapinski et al., 2012). Principle II guides teachers in the development of curricula that integrate additional options for active learning and communications as students engage in a comprehensive learning experiences throughout each cycle of the learning process (CAST, 2011).

Guideline 4

Guideline 4 considers barriers that may exist for physical responses (CAST, 2011). Printed educational resources provide limited ways for students with physical disabilities and students who need executive function support to respond, interact with content, and navigate through material (Gordon et al., 2012). AT devices need to be seamlessly embedded in the lesson design to facilitate learning (CAST, 2011). Speech recognition and word processing software are designed to support writing composition and reinforce spelling and grammar; text-to-speech software reads full-text, challenging

words, or text as students type; inspiration software provides access to hyperlinks and uses graphic organizers to support metacognition (CAST, 2011). AT software enable students to fully engage in the standards-based curriculum and learn new concepts without frustration while reinforcing basic academic skill development (Messinger-Willman & Marino, 2010; Zascavage & Winterman, 2009).

Guideline 4 Significance for Learning

AT supports the cognitive needs of students with learning disabilities who have working memory deficits and provides them with greater access to the standards-based curriculum. The purpose of transitioning students with learning disabilities from the confined special education classroom, that primarily focused on basic academic skill and functional skill development, to the general education classroom was to provide accommodations, modifications, and supports for grade-level standards-based learning in order to prepare students for state assessments and provide them with the opportunity to further their educational goals, not to isolate basic academic skill development in technology-based and nontechnology-based learning environments (IDEA, 2004). Curricula and supports are needed that bridge individual areas of need to the learning goal.

Many students diagnosed with a specific learning disability have reading and writing delays and need support in secondary education to fully engage in standards-based curricula independently (Zascavage & Winterman, 2009). They often encounter barriers in the curriculum (i.e., content, teaching and learning methods, instructional

materials, and assessments) that hinder the learning process and lead to frustration (Messinger-Willman & Marino, 2010; Zascavage & Winterman, 2009). AT have the capability to support decoding, metacognition and reading comprehension, and improve the productivity of written assignments (Zascavage & Winterman, 2009).

Word processors provide instant feedback for sentence structure and mechanical writing errors. Writing is a difficult skill to master. K – 12 students will need to master their writing skills to be successful in postsecondary education and their future careers. Students need numerous writing opportunities to develop their writing skills. It is difficult for teachers to give students the timely feedback needed to become successful writers, and students may not always apply the feedback they receive from previous writing assignments. Some students habitually make the same errors every time they write and never master their writing skills. It is also difficult for teachers to find the time to grade the numerous writing assignments students need to write to develop their writing skills, especially if the writing is not legible. Word processors support the development of the writing skills needed to become good writers. They provide instant feedback for sentence structure, spelling, and grammatical errors that allow for leverage as students engage in writing activities.

Englert, Wu, and Zhao (2005) found that scaffold instruction designed to support the stages of the writing process in a digital learning environment with a word processor to support mechanics, text-to-speech software to support revisions, and constructive feedback from teachers and peers significantly improved the quality of writing for primary school students with learning disabilities. Research has also shown that speech

recognition and word processing software significantly improved the language arts skills of high school students who struggled with reading and writing (Lance, McPhillips, Mullern, & Wylie, 2006), and speech recognition software improved the quality of writing for primary school students with learning disabilities (Cullen, Richards, Frank, 2008). Word processing software improved the quality of writing for high school students with disabilities (Bouck, Doughty, Flanagan, Szwed, & Bassette, 2010; Hetzroni & Shrieber, 2004), and primary, middle, and high school students without learning disabilities (Quinlan, 2004).

Since the enactment of the Technology-Related Assistance for Individuals with Disabilities Act (Tech Act, 1998), many of the legislation's recommendations and requirements, such as evaluation of AT needs, services, and training are not being implemented in educational settings. Alper and Raharinirina (2006) analyzed 68 AT studies published since the legislation was enacted and identified barriers that prevented successful implementation of AT for students with learning disabilities. Barriers for successful implementation of AT in all educational settings included limited financial resources, a lack of information provided to families for students with disabilities, and a lack of training and ongoing support (Alper & Raharinirina, 2006). The majority of the studies reviewed did not include an evaluation to identify the individual's needs prior to the selection of the device (Alper & Raharinirina, 2006).

AT software have the potential to maximize learning for students with disabilities. IDEA (2004) and ESSA (2015) mandate high quality standards for all students; however, neither law mandates implementation of AT devices. The effective use and

implementation of AT in the K – 12 setting is an ongoing problem that persists (Messinger-Willman & Marino, 2010; Zascavage & Winterman, 2009). Problems occur with AT devices when teachers have to manage students with various disabilities and the various assistive technologies that are designed to eliminate learning barriers (Schaaf, 2013). Technology should be designed to support instruction, so that it does not overwhelm teachers (Schaaf, 2013). Sometimes AT devices can distract teachers from teaching, and a solution to the problem may be to seamlessly incorporate AT in a digital learning environment (Schaaf, 2013). While observing a special education classroom for students with hearing impairments, Scaaf (2013) observed a teacher who used an interactive Smartboard with a sound amplifier to provide instruction for all the students in the classroom. Using one device to accommodate the various cognitive and physical needs of a given student population allows teachers to focus on learning instead of having to manage multiple assistive technology devices during instruction (Schaaf, 2013).

Since NIMAS became a part of IDEA 2004, new technology learning environments have been developed that merge AT – access for the individual and UDL – access for all (Gordon et al., 2009). Rappolt-Schlichtmann et al. (2013) examined the use of the Universal Design for Learning Science Notebook (UDLSN) in primary school science classrooms. The UDLSN has built-in features that include text-to-speech, English-to-Spanish translations, descriptions for visuals, and a multimedia glossary for vocabulary development (Rappolt-Schlichtmann et al., 2013). The contextual components of the UDLSN are designed to support the learning process that include captioned videos with prompts to facilitate and guide students as they build an

explanation, reminders to reference their data and observations, and reminders to use relevant vocabulary (Rappolt-Schlichtmann et al., 2013). It also provides options for responding that include typing, drawing, audio recording, or uploading a picture, and teachers can easily provide feedback to support self-regulation and motivation (Rappolt-Schlichtmann et al., 2013). Students reported an overall positive experience with the UDLSN and higher levels of interest, enthusiasm, critical thinking, autonomy, and feelings of competency (Rappolt-Schlichtmann, 2013).

Guideline 5

Guideline 5 considers the different ways students engage in learning and communicate what they have learned (CAST, 2011; Lapinski et al., 2012). A variety of technology- and nontechnology-based tools and learning strategies are needed for composition, problem-solving, practice, and collaboration (CAST, 2011). Some students may need to see the task modeled in different ways and need faded scaffolds and constructive feedback to fully engage in learning that allows for leverage (CAST, 2011; Lapinski et al., 2012).

Guideline 5 Significance for Learning

To reduce extraneous working memory load, key content needs to be highlighted as students engage in the learning process, so they can focus on relevant information instead of information that is not relevant to the learning process (Renkle & Atkinson, 2007). To reduce intrinsic working memory load, the difficulty of the learning task must be reduced to accommodate the needs of novice learners who are engaging in a complex learning task (Renkle & Atkinson). Instead of using leveled scaffold instruction for

problem solving that attempts to reduce extraneous cognitive overload by first providing modeled exemplars in the initial stages and strategies for problem solving to reduce intrinsic cognitive overload in the final stages, Atkinson and Renkle (2007) found that the simultaneous implementation of faded scaffolds for problem solving and modeled exemplars combined during problem solving instruction improved students' ability to solve problems independently.

Liu and Bera (2005) examined how primary school science students used problem solving strategies. Scaffold problem solving strategies for information gathering and organizing, highlighted key concepts, and exemplars for different problem solving strategies that modeled the interaction between factual/declarative knowledge and procedural knowledge were seamlessly embedded in a hypermedia learning environment (Liu & Bera, 2005). To reduce short-term memory overload and enhance higher order thinking, metacognitive supports are needed for basic academic skills and to supply or activate the background knowledge needed to learn new material (Jonassen, 1996; Lajore, 1993). The ability to solve problems would be beyond the reach of a novice learners' ZPD (Vygotsky, 1978) without the appropriate scaffolds and supports (Lu & Bera, 2005). Lower-performing students used fewer strategies in the final stages of problem solving than higher-performing students did in the Liu and Bera (2005) study. Low performing students and students with disabilities need explicit scaffold instruction to support lower and higher executive functions (CAST, 2011; Jackson et al., 2005).

Although teachers are aware of the strengths and areas of need for their given student population through observation and valid formative and summative assessment

data, instruction is differentiated to accommodate all the varied abilities and academic needs of a given student population in a universally designed learning environment (Jackson et al., 2005). Marino, Coyne, and Dunn (2010) investigated the effect readability level had on below average middle school readers' comprehension of scientific concepts and vocabulary as they engaged in inquiry-based learning in a universally designed digital environment. The digital environment included graphic organizers, visual representations, cues, prompts, and interactive tutorials to support metacognition, facilitate critical thinking analysis, and promote self-monitoring (Marino et al., 2010). Teachers also provided additional support for inquiry-based learning activities that included explicit questioning, small and large group discussions, and practice that required students to demonstrate their conceptual understanding of the learning content (Marino et al., 2010).

Pretest/post-test assessments measured students' ability to identify and explain concepts, processes, and related terms in the Marino et al. (2010) study. There was no statistically significant difference found between students with below average reading abilities and students who had proficient reading skills (Marino et al.). Findings suggested that other scaffolds included in the UDL digital learning environment may have helped students with reading deficits compensate for their limited skills, and teachers and researchers noted that students in the treatment group chose to access information in alternative formats instead of using the readability level electronic text (Marino et al.). UDL curricula may be better suited for improving learning outcomes with this student population (Marino et al., 2010).

King-Sears et al., (2015) conducted an exploratory study to compare a universally designed technology-based learning environment and traditional teaching and learning instruction and materials to determine whether there was a significant difference on student performance, and also found that a universally designed learning environment was better suited for low-performing students. Participants included high school students with and without disabilities (King-Sears et al.). The UDL learning environment students engaged in included a step-by-step self-management strategy on how and when to use one-step or two-step processes to solve chemistry problems, “a graphic procedural facilitator” (p. 89) to support basic academic skill development and background knowledge as students engaged in content learning, videos that verbally and visually modeled how problems were solved by highlighting each part of the problem solving process using animations such as arrows or underlining, and gradually faded scaffold supports until students were able to work independently. Pretest/post-test scores showed no significant difference between the treatment and control group; however, post-test scores showed an interaction effect between students with disabilities and students without disabilities (King-Sears et al., 2015).

Guideline 6

Guideline 6 offers ways to help novice learners become independent expert learners (CAST, 2011). Teachers should establish short-term goals for students based on observation and formative and summative assessment data for long-term-goal attainment, and evaluate student progress to modify strategy use if needed (CAST, 2011; Lapinski et al., 2012). It is vital that teachers understand that “executive functions have limited

capacity due to working memory” (CAST, 2011, p. 25). The capacity is reduced when students, for example, focus on decoding when reading instead of engaging in critical thinking reading comprehension (i.e., compare/contrast, inferences, cause and effect), or when students have a learning disability or lack the expertise to use a strategy (Gordon et al., 2012). By scaffolding lower level skills and higher level skills, cognitive overload is reduced and the capacity for higher order thinking increases (CAST, 2011).

Guideline 6 Significance for Learning

A curriculum-based monitoring system is a circular action research method teachers use to continuously monitor student progress and inform instruction for a specific student population (Vue & Hall, 2012). Frequent formative assessments are administered to make informed decisions about lesson planning (Vue & Hall, 2012). When instruction does not show that it improved student learning, instructional modifications need to be made based on assessment results and further evaluation/formative assessment is needed to evaluate whether the modifications were effective (Vue & Hall, 2012). The assessment should only be used for a grade if the results show that modifications effectively communicated curriculum standards to students (Jackson et al., 2005; Vue & Hall, 2012).

Research has shown that a curriculum-based monitoring system improved standardized assessment reading and math scores for students with learning disabilities and students without learning disabilities (Stecker, 2005). However, there were specific variables associated with academic achievement for students with learning disabilities: feedback and modified instruction (Stecker, 2005). For example, Stecker and Fuch (2000)

investigated the effect of implementing a curriculum-based monitoring system for elementary, primary, and middle school students with learning disabilities where short-term goals were adjusted for long-term goal attainment. Students were assessed every 1 to 2 weeks over the course of the school year (Stecker & Fuch, 2000). The computer-based monitoring program provided teachers with a skill analysis to adjust instruction and, students were shown a graph that displayed their progress over time (Stecker & Fuch, 2000). Students whose teachers modified instruction based on the data scored significantly higher on the achievement test than students who did not have their instruction modified based on curriculum-based measurement data (Stecker & Fuch, 2000).

Recent studies have also shown positive outcomes when curriculum-based monitoring systems were used to improve the quality of learning and learning outcomes for elementary school students who needed tailored instruction. Forster and Souvignier (2011) found that a computer-based assessment system intervention improved reading fluency and comprehension for elementary school students with learning disabilities. Jitendra, Dupis, and Zaslofsky (2014) examined the effect a curriculum-based monitoring system had on elementary school students who were at-risk of failing math due to their inability to solve mathematical word problems. Students were assessed every 2 weeks over the course of a 3 month period (Jitendra et al., 2014). After each assessment, students participated in small group instruction for one- and two-step mathematical word problems that incorporated all the sub-standards of the standards-based curriculum (Jitendra et al., 2014). Students not only showed consistent growth on the bi-weekly

curriculum-based assessments, they also showed growth on the end of school year standardized achievement test (Jitendra et al., 2014).

CAST created a triad technology-based teaching and learning system to support reading comprehension that consists of a universally design digital reading environment with integrated multimedia to supply background knowledge and prompts to respond to reading comprehension strategy questions as students read, a discussion forum, and curriculum-based monitoring system (Cohen, Hall, Vue & Ganley, 2011; Hall, Cohen, Vue, & Ganley, 2015). The system generates, administers, and scores formative assessment data so teachers can focus on data analysis and instruction, and teachers can easily interact with students and monitored their reading fluency and reading comprehension progress to make informed decisions about further instruction if needed (Cohen et al., 2011; Hall et al., 2015). Teachers participating in triad technology-based teaching and learning system studies accessed data more frequently, made more instructional changes, designed more instructional interventions, and coached students more in the interactive discussion forum than teachers who did not have access to the online progress monitoring system (Cohen et al., 2011; Hall et al., 2015). Although curriculum-based monitoring systems have been shown to improve learning outcomes for students with and without learning disabilities, constructive feedback and modified instruction based on curriculum-based assessment data improved the academic performance of students with learning disabilities (Cohen et al., 2011; Hall et al., 2015; Sovigner, 2011; Stecker, 2005; Stecker & Fuch, 2000).

Principle II Significance of Teaching and Learning

In the van Kraayenoord et al. (2014) case study, teachers participated in a school-wide effort to improve the literacy of students with learning disabilities in inclusive classrooms. They found that word prediction software, text-to-speech software, and word processing spell checks increased student engagement, time on task, and decreased frustration (Kraayenoord et al.). They also found that reading comprehension levels increased for all students, general and special education students, when graphic organizer, word-making, and explicit reading comprehension digital tools were implemented in the lesson design (van Kraayenoord et al., 2014).

Preservice teachers enrolled in early childhood preparation programs participated in the McGuire-Schwartz and Arndt (2007) study. They used multiple qualitative and quantitative action research methods to collect data during their practicum that included observations, pretest and post-test student work samples, and reflections of their experience (McGuire-Schwartz & Arndt). The results of the study showed that participants developed an increased awareness of student diversity, found that universally designed lessons increased students' understanding of the curriculum, and increased student involvement and interest (McGuire-Schwartz & Arndt, 2007).

Research has shown that preservice and inservice teachers improved their ability to implement Principle II in the lesson design to support diversity in strategic brain network functions. Preservice teachers participating in the Spooner et al. (2007) study were evaluated for their ability to develop lessons according to the three UDL principles after participating in UDL training. The results of the experimental group showed a

significant difference for expression ($p < .001$) when compared to the control group. Teachers participating in the Baldiris Navarro et al. (2016) also demonstrated their ability to implement action and expression components in the lesson design following UDL professional development: District 1 (pretest $M = 1$; post-test $M = 2.88$), District 2 (pretest $M = 1.53$; post-test $M = 2.82$), and District 3 (pretest $M = 1.07$; post-test $M = 2.71$).

Fifty-four percent of the teachers participating in the Dalton and Smith (2012) study took advantage of the scaffold strategic options designed to support critical thinking in the online learning environment. They also asked more students to create multimedia projects (Dalton & Smith, 2012). Thirty-two percent of the teachers asked students to create projects that only required a written response, and 58% asked students to create projects that had text and visuals (Dalton & Smith, 2012). Students in the CAST case studies engaged in a variety of technology and nontechnology-based ways to express learning; they performed an enactment with a team, developed multimedia presentations, wrote a book for another grade level, wrote poems, and conducted research projects (Meo, 2008).

Principle III

Principle III and Guidelines 7, 8, and 9 of the UDL framework support affective brain network functions by addressing the different ways students become motivated and sustain their engagement even when the learning task becomes difficult or boring (CAST, 2011; Lapinski et al., 2012). Others may lose interest and disengage (Lapinski et al., 2012). The UDL framework supports the different ways learners become motivated to

learn and stay engaged in learning by recommending that teachers develop curricula that offer choices of learning materials to recruit interest and adjust the level of challenge and support for learning tasks to sustain interest and allow for leverage (CAST, 2011).

Guideline 7

Guideline 7 considers the different ways students get interested and stay engaged (CAST, 2011). When information is presented in a manner that does not engage students, they cannot see the relevance of learning (CAST). To engage students and attract their interest, teachers need to consider students' developmental level and prior knowledge in order to adjust the level of challenge for the learning task and allow for leverage, offer choices for content (i.e., create a video) and tools (i.e., drawing), and personalize learning, relating information to students' life and culture (CAST, 2011).

Guideline 7 Significance for Learning

Patall, Cooper, and Robinson (2008) conducted a meta-analysis of the effects choice had on motivation and learning in a variety of educational settings. An analysis of 41 studies revealed that choice positively affected motivation, performance, competency, and learning (Patall et al., 2008). However, when participants had negative perceptions about the manipulation, choice was not effective (Patall et al., 2008). Choice was found to be most effective when intrinsic motivation was involved, when a few choices were offered, and when external motivation was not involved (Patall et al., 2008). It had the greatest effect when choices matched the cognitive and social-emotional needs of learners and was least effective when participants felt persuaded to make a choice or when given an attractive alternative (Patall et al., 2008). Nickoopour, Salimian, Salimian,

and Farsani (2013) found that intrinsic motivation positively impacted learning strategy use (metacognition) and memory (cognition), and extrinsic motivation negatively impacted learning strategy use and memory.

Choice is not always a predictor of autonomy or intrinsic motivation. Research has shown that independent thinking that allowed for criticism and a communicated value for learning content had stronger impacts on elementary, primary, and middle school students' engagement than choice (Assor, Kaplan, & Roth, 2002). Schuh and Farrell (2006) found that choice had no impact on learning outcomes. There was not a significant difference in the quality of primary school students' informative writing when given the choice to conduct research on the internet or use printed text; however, students were intrinsically motivated to engage in the learning task (Schuh & Farrell, 2006). Students reported that they put more effort into their writing when they were given the choice to conduct their research on the internet (Schuh & Farrell, 2006).

Students may not always get motivated to learn when choice is based on interest, or when students are not offered a broad range of learning contexts and materials to discover alternative learning preferences of which they were not previously aware to express what they have learned. Children and adolescents have a natural sense of curiosity and want to learn about new things that challenge their minds and new ways to learn within the reach of their capabilities. Research has shown that choice based on interest and prior knowledge had no impact on learning outcomes; however, curiosity about a new topic with no existing knowledge positively impacted learning outcomes and students' perceptions about learning (Flowerday, Schraw, & Stevens, 2004).

Choice affect may depend on the type of choice being offered and the content being addressed. High school students reported that they preferred a real-world contextual learning environment when engaging in mathematical problem solving instead of the course textbook (Julie, 2013). A universally design learning environment offers a variety of technology and nontechnology-based learning materials for engagement and expression (CAST, 2011). When high school algebra and biology teachers were trained on the principles of UDL and were shown examples of how to implement UDL in their classrooms, 75% of their students reported that they liked the hands-on activities, educational games in which they participated, the variety of activities to which they were exposed, and the incentives embedded within the curriculum (Kortering, McClannon, & Braziel, 2008). Students also reported that they understood the content better in a UDL learning environment compared to traditional instruction and materials (Kortering et al., 2008).

Guideline 8

Guideline 8 considers the appropriate degree of scaffolds and supports that need to be implemented in the lesson design to challenge students and allow for leverage without frustration (CAST, 2011; Lapinski et al., 2012). Some students may lose interest in the learning task if it is too easy; others may get frustrated if the task is too challenging (CAST, 2011; Lapinski et al., 2012). Teachers cannot always provide the individual attention and feedback that some students may need to persist in learning tasks. Peer-mediated learning is a scaffold learning strategy where a higher-performing student plays an instructional role with a lower-performing student (King-Sears, 2001). Peer-mediated

learning can also be defined as reciprocal teaching when students take turns playing the instructional role (Topping, 2001). Research has shown that peer-mediated learning was an effective strategy to use with students who have learning disabilities, because it allowed them to receive one-on-one instruction and immediate feedback (Stenhoff & Lingugaris-Kraft, 2007).

Guideline 8 Significance for Learning

Peer-mediated learning can have positive academic and social-emotional implications for mixed-ability classrooms. In a review of research that evaluated the effectiveness of peer-mediated instruction for reading development in the K – 12 inclusive setting, McMaster, Fuchs, and Fuchs (2006) found that kindergarteners improved their beginning reading skills, primary students improved their fluency and reading comprehension skills, and secondary education students improved their reading comprehension skills when they developed their skills in a peer-mediated learning environment. Although most students improved their reading skills, some of the low-performing students and students with learning disabilities did not improve their reading skills even when additional interventions were implemented (McMaster et al., 2006). However, students with learning disabilities reported that they felt more accepted in inclusive classrooms that implemented the peer-mediated learning strategy than classrooms that did not implement it (McMaster et al., 2006). Research has also shown social-emotional benefits for K – 12 students when peer-mediated learning was implemented in mixed-ability classrooms (Gingburg-Block, Rohrbeck, & Fantuzzo, 2006; Miller, Topping, & Thurston, 2011).

Recent studies have evaluated the effect of peer-mediated learning in digital learning environments. Although prepackaged learning environments emphasize conceptual learning, most of them do not cover the content-area learning objectives for curricula-based standards (Tsuei, 2014). Kong (2008) created and investigated the effect of a computer-based peer-mediated program designed to communicate mathematical concepts with visual representations and supports for mathematical operations that developed primary school students' procedural knowledge and conceptual understanding of concepts.

Tsuei (2011) developed and explored the effect an online peer-mediated system had on primary school students' reading skill development. The teachers first trained higher-performing students who were assigned as tutors to answer questions and provide feedback to low-performing students (Tsuei, 2011). Students in the online peer-mediated environment showed more growth in reading skill development than students who did not participate in the online environment (Tsuei, 2011). In a more recent study, Tsuei (2014) developed and evaluated an online peer-mediated learning environment designed to enhance learning for primary school students with learning disabilities that consisted of an interactive Smartboard with visual representations and symbols and scaffolds that provided peer tutoring instruction, task organization strategies, and feedback to use as students engaged in conceptual mathematical problem solving applications that were differentiated according to their ability. The results indicated that students with learning disabilities improved their understanding of mathematical concepts (Tsuei, 2014).

Guideline 9

Guideline 9 is the guideline that is practiced the least in classrooms, because it focuses on developing students' intrinsic motivation instead of focusing on the external learning environment (Lapinski et al., 2012). To develop intrinsic motivation and life-long learning, teachers can create a learning environment that promotes self-regulation by modeling self-regulating strategies and teaching coping skills using prompts (CAST, 2011; Lapinski et al., 2012). Students need to understand their strengths and areas of need, establish short-term goals, and monitor their progress (CAST, 2011; Lapinski et al., 2012).

Guideline 9 Significance for Learning

Expert learners understand that through continuous practice, effort, and commitment they will reach their learning goal (Meyer et al., 2014). They use constructive feedback wisely, develop their own strategy use, and adapt new strategies to improve their performance (Meyer et al., 2014). Students who view learning as an ongoing developmental process are goal-oriented learners (Dweck, 2006). Most students have adopted one of two theories about intelligence that influence their motivation for learning, self-regulation, and academic performance: (a) entity theory – the belief that intelligence and ability are innate and cannot be changed; or (b) incremental theory – the belief that intelligence is developed through effort (Dweck, 1999; Dweck & Leggett, 1988). Students who have adopted an entity theory are performance goal-oriented – they seek extrinsic motivation represented by grades and other rewards (Dweck, 1999; Dweck & Leggett, 1988). Students who have adopted an incremental theory are goal-oriented

learners – they are intrinsically motivated, engaged, and work diligently to improve their competency (Dweck, 1999; Dweck & Leggett, 1988).

Blackwell, Trzesniewski, and Dweck (2007) conducted two studies that explored the influence intelligent beliefs had on middle school students' mathematical achievement over the course of a 2 year period. In the first study, researchers measured students' implicit theory beliefs before they started middle school and found that the academic achievement of students who had a perceived incremental theory of intelligence increased throughout middle school (Blackwell et al., 2007). In the second study an intervention teaching incremental theory using self-regulating strategies was administered to middle school students that promoted positive changes in motivation (Blackwell et al., 2007). Students in the control group showed an overall decline in academic achievement throughout middle school, but the decline was reversed in the experimental group (Blackwell et al., 2007). Current research has also shown a positive relationship between motivation, self-regulation, and academic performance that supports the incremental theory of intelligence (Davis, Burnette, Allison, & Stone, 2011; Ratton, Good, & Dweck, 2012; Yeager & Dweck, 2012).

Self-regulated learners are expert learners who are actively involved in the learning process (Effeney, Carrol, & Bahr, 2012). They plan, apply learning strategies effectively, and monitor their behavior to complete a learning task (Effeney et al, 2012). Ocak and Yamac (2013) examined the relationship between self-regulation, motivation, and academic performance and found that self-directed learning was related to “task value, self-efficacy, and goal orientation” (p. 383). Lodewyk, Winnie and Jamieson-Noel

(2009) compared the effects structured self-regulatory tasks had on high school students' behavior to the behavior of students who did not engage in structured tasks and found that students who engaged in structured tasks applied more critical thinking, demonstrated better management capabilities, and more accurately assess their progress.

It is important that teachers establish a learning environment that promotes goal orientation, develops students' self-regulatory efficacy, and identifies students' areas of need to improve learning processes (Meyer et al., 2014). To help novice learners become expert learners, learning process need to be clearly communicated through explicit scaffold instruction and practiced across content areas that include the writing process, steps in mathematical and scientific inquiry problem solving that incorporate factual/procedural knowledge within conceptual learning experiences, and integrated guided prompts and cues for reading comprehension strategies that foster critical thinking while reading fiction and nonfiction text. Explicit instruction is not a passive learning process, but an active one where teachers and students interact in a meaningful way (Smolkin & Donovan, 2001). Although most teachers provide modified instruction that accommodate diverse student populations in inclusive classrooms, there are still individual differences in self-regulatory efficacy that need to be addressed to develop intrinsic motivation (Yeager & Dweck, 2012).

Principle III Significance for Teaching and Learning

When UDL lesson plan development training was provided, preservice and in-service teachers demonstrated their ability to implement Principle III in the lesson design to create a classroom climate that would be conducive for learning. Preservice teachers

participating in the Spooner et al. (2007) study significantly ($p = .011$) improved their ability to implement engagement components in the lesson design after participating in a 1-hour training on UDL lesson plan development. Teachers participating in the Baldiris Navarro et al. (2016) study also demonstrated their ability to implement engagement components in the lesson design following UDL professional development: District 1 (pretest $M = 1$; post-test $M = 2.88$), District 2 (pretest $M = 1.53$; post-test $M = 2.94$), and District 3 (pretest $M = 1.07$; post-test $M = 2.71$). The results of these studies did not indicate which UDL guidelines teachers used for each of the three UDL principles.

Preservice teachers in the Williams et al. (2012) study used a self-assessment tool to rate their proficiency for implementing UDL principles in the lesson after participating in a course designed to prepare them to teach in inclusive classrooms. Descriptive statistical analysis showed a significant difference between the pretest/post-test mean scores, and a paired sample t-test determined that the mean on the pretest/post-test measures differed significantly (Williams et al.). Eighty percent of preservice teachers rated themselves as proficient for implementing Principle I in the lesson design, 67% rated themselves proficient for implementing Principle II; however, only 60% rated themselves as proficient for Principle III (Williams et al., 2012).

McGhie-Richmond and Sung (2013) examined the changes preservice teachers and practicing teachers made to previously taught lesson plans after learning about the broad spectrum of learning disabilities and learner variability, UDL principles and guidelines, and UDL lesson plan development and found that preservice teachers made

fewer revisions to existing lesson plans for Principle III – Guideline 9 than practicing teachers (McGhie & Richmond, 2013). Practicing teachers were able to demonstrate their awareness of the broad range of student capabilities that exist in inclusive classrooms and understood the importance of teaching explicit self-monitoring strategies to novice learners.

Experiencing UDL in Teacher Preparation Programs

Special education teachers collaborate with members of an Individualized Education Program (IEP) team that include medical personnel and school staff and analyze data to develop IEPs for special education students. They also provide services according to IEP goals and communicate with IEP team members on a consistent basis to ensure that the appropriate accommodations and modifications are being implemented for students with disabilities in the inclusive setting. It is not always possible to communicate with team members in person due to scheduling conflicts. Preservice special education teachers need to develop their collaborative skills, and learn how to use online collaborative tools in their teacher preparation courses to be successful in practice (Basham, Lowery, & deNayelles, 2010). A well designed computer-mediated communication (CMC) system has the potential to develop both of those skills (Basham, Lowery, & deNayelles, 2010).

Basham et al. (2010) discovered that the UDL framework was an effective guide for the instructional design of a CMC system. Instructors from two universities who taught similar courses about teaching and learning in the inclusive setting and preservice

teachers participated in the Basham et al. study, and a CMC learning environment was created to foster collaboration between the two universities. The instructors provided consistent feedback and interacted with students in the CMC learning environment and onsite campus classroom (Basham et al.). Students used a variety of collaborative tools in the CMC learning environment, the CMC discussion forum and face-to-face communications, to engage in problem solving activities and collaborate on course projects (Basham et al.). Project materials were scaffold, important information was highlighted, materials were offered in different formats, and AT support and multiple sources were provided for research and information processing (Basham et al.). Basham et al. (2010) also discovered that a CMC learning environment based on UDL facilitated critical thinking.

Scaffold instruction has been shown to significantly impact learning outcomes for novice learners in K – 12 learning environments (King-Sears et al., 2015; Marino et al., 2010). To some degree, preservice teachers are novice learners when it comes to teaching and learning. Some may have some background knowledge about teaching and learning, but each have a different set of skills and experiences that they bring to the learning environment. They do not enter teacher preparation programs as expert teachers. Effective teaching and learning knowledge and skills are needed before preservice teachers begin teaching in K – 12 classrooms. To transform novice learners into expert teachers and increase preservice teachers' self-efficacy about teaching in K – 12 inclusive classrooms, preservice teachers need to be exposed to learning environments that are constructed from an evidence-based instructional and curricula development framework.

Doering and Veletsianos (2007) examined the ability of preservice and inservice teachers enrolled in two educational technology courses to solve problems in a multimedia scaffold learning environment and the impact the environment had on cognitive overload when solving real-world problems. Participants in the Doering and Veletsianos study had access to four digital scaffolds: videos that provided data about real-world problems, videos that demonstrated the use of the digital environment to solve problems, an artificial agent that conversed with participants, and a discussion section that provided support from peers and coaches when needed. Doering and Veletsianos found that there was a significant relationship between videos demonstrating how to use the digital environment to solve real-world problems and problem-solving ability, but no significant relationship between the other three scaffolding tools and problem-solving ability. However, there was a significant relationship between cognitive overload and all four scaffolding tools (Doering & Veletsianos, 2007).

Research has shown that multimedia learning environments significantly improved K – 12 learning when UDL was implemented in the instructional and curricula design and key content were highlighted to reduce cognitive overload – freeing working memory for more complex learning tasks (Kennedy et al., 2014; Korat et al., 2014; Leahy & Sweller, 2011; Yung & Paas, 2015). Teachers candidates need to experience learning in a multimedia learning environment to effectively and efficiently learn how to embed digital tools in the K – 12 curriculum (Anderson, Sanderford, & Imdieke, 2010; Kennedy & Achambault, 2012; Ko & Rossen, 2010). Ho (2014) conducted a case study to explore whether preservice teachers felt more prepared to teach in a multimedia learning

environment after engaging in an online teacher preparation course based on UDL principles. Students were offered a variety of online tools for communication and collaboration, multiple ways to access information through different modalities, multiple ways to engage in learning, and course projects were strategically designed to facilitate higher order thinking (Ho, 2014). Participants reported feeling confident about teaching in a multimedia learning environment and felt they mastered the use of digital instructional tools that could be embedded in K – 12 curricula to create universally designed lessons for their future students (Ho, 2014).

Yang, Tzuo, and Komara (2011) argued that if preservice and inservice teachers were to implement higher order thinking, collaboration, technology, and UDL in practice, they must first experience these practices in teacher preparation programs. Yang et al. (2011) investigated whether the use of Web Quest, a technology-based teaching and learning tool created by Dodge (2001) for inquiry-based problem-solving, in teacher preparation courses promoted special education teacher candidates' understanding of UDL, enhanced their higher order thinking skills, and motivated them to want to integrate technology leaning tools in their future classrooms. The instructor provided resources on the topic of inquiry, authentic learning tasks, and structure that guided learning processes and interactions within the learning environment (Yang et al., 2011). After experiencing WebQuest, special education preservice teachers felt it was an effective approach for accommodating individual differences, enhancing higher order thinking and problem-solving, and felt more knowledgeable about implementing UDL curricula and technology in their future K – 12 classrooms (Yang et al., 2011).

Research has often documented positive outcomes for preservice teachers that included an increase in the knowledge and skills needed to meet the academic needs of diverse student populations when preservice training incorporated differentiated teaching and learning methods in the curriculum; however, there have been few follow-up studies documenting the benefits after teacher candidates became teachers (Brown et al., 2008). Many educational instructors of teacher preparation courses discuss and promote the implementation of UDL in practice, but fail to apply the principles of UDL to their own teaching (Ashman, 2010). Ashman (2010), an instructor at the University of Queensland in Australia, incorporated the fundamentals of UDL in two online graduate courses for practicing teachers that included providing consistent feedback based on curriculum goals and expectations, building the background knowledge needed to fully engage in the curriculum, and alternative options for assessing student learning based on skill, learning preference, and interest. After experiencing learning in a UDL context, the teachers felt better equipped to develop and deliver universally designed curricula in their classroom settings (Ashman, 2010).

UDL: Preparing Teachers to Teach in Inclusive Classrooms

The majority of students with disabilities spend 80% of their time in the inclusive setting (U.S. Department of Education Office of Special Education Programs, 2012). The issue is not whether students with learning disabilities are physically included in the general education classroom, but whether they are socially included and cognitively engaged. Nineteen percent of students with learning disabilities drop out of high school (National Center for Learning Disabilities, 2013). The unemployment rate for this

population is more than 12%, and the average weekly income is 471 dollars (National Center for Learning Disabilities, 2013). Additionally, students with disabilities who do graduate from high school do not succeed in postsecondary education, because they are not adequately prepared (Sanford et al., 2011; U.S. Department of Education Office of Special Education Programs, 2012).

There is a need for teacher training that emphasizes an awareness of diversity in learning and UDL lesson plan development in order to meet the academic needs of diverse learners (Baldiris Navarro et al., 2016). A survey was conducted in 50 suburban and urban Missouri school districts that included 188 elementary and secondary special and general education teachers with varied teaching experience and education (Myers et al., 2008). The results indicated that 65% of teachers never heard of UDL, 85% had never received UDL training, and 75% never used UDL in their classrooms (Myers et al., 2008). Of the 25% who reported using UDL, only 9% used it consistently in their classrooms (Myers et al., 2008). Recent graduates of teacher preparation programs have become more aware of student diversity in learning and have been trained on UDL lesson plan development. According to Hehir (2009), the inclusion of UDL in the HEOA will prepare teacher candidates to design and implement UDL lessons; however, there is a lack of UDL inservice being provided even though IDEA 2004 funds UDL professional training.

The U.S. Department of Education (2010) awarded grants to universities through their Teacher Quality Enhancement program to have UDL incorporated in special and general education teacher preparation programs and to ensure that preservice teachers

could implement instructional technology tools based on UDL principles and guidelines in the lesson design. Five hundred and eighty instructors from 58 general education teacher preparation programs in 22 states participated in a survey to determine whether UDL was actually being implemented in general education preservice coursework (Vitelli, 2015). Of the 580 instructors surveyed, 350 reported that they were aware of UDL, 353 reported having basic knowledge about UDL, and 140 taught UDL to their preservice teachers (Vitelli, 2015). Of the 140 who did implement UDL in the curricula, 105 implemented Guideline 1, 89 Guideline 2, 116 Guideline 3, 85 Guideline 4, 132 Guideline 5, 72 Guideline 6, 113 Guideline 7, 120 Guideline 8, and 100 implemented Guideline 9 (Vitelli, 2015).

While IDEA (2004) amendments have enabled students with disabilities to be included in general education classrooms, general education teachers still feel that they are not prepared to meet the needs of an academically diverse student population. Fuchs (2010) explored some of the problems general education teachers encountered when they taught in inclusive classrooms and found that teachers felt they could not meet the demands and expectations placed upon them. They also felt that their postsecondary education programs did not prepare them to teach in inclusive classrooms and that school districts did not provide the adequate training and support needed to meet the demands and responsibilities expected of them (Fuch, 2010).

In inclusive classrooms, general education teachers are expected to have a broadened scope of pedagogy in order to differentiate the challenge level to allow for leverage, engage all learners, and provide alternative modes of assessments (King et al.,

2010). Preservice teachers need to be able to meet the academic needs of all students in their future classrooms instead of learning how to prepare whole group instruction that needs to be modified (King et al., 2010). They also need to learn how to eliminate barriers in the general education learning environment and be able to develop proactive lessons to be prepared to teach in inclusive classrooms (Gargiola & Metcaff, 2010; King et al., 2010). However, current research indicated that special and general education preservice teachers did not feel prepared to teach in inclusive classrooms; they did not see a connection between the knowledge and skills learned in their coursework and the reality observed in inclusive classrooms during their practicum (Gehrke & Cocchiarella, 2012; Gill et al. 2009). This disconnect may be partly due to the teaching and learning beliefs of general education instructors (Gehrke & Cocchiarella, 2012; Gill et al. 2009). Research has indicated that some instructors resisted implementing UDL in the general education teacher preparation curriculum (McGuire-Schwartz & Arndt, 2007; O'Brien, Aquinaga, Mundorf, 2009). Some stated that they did not have the time or materials needed to integrate UDL in the coursework (Maryland UDL Task Force, 2011). Others had a misconception that UDL was only for special education, and that it would not be applicable for the general education student population (Maryland UDL Task Force, 2011).

Methodology

Most of the research that addressed the UDL framework and learning outcomes were quantitative studies. It was vital to address these studies in the literature review to understand how preservice and inservice UDL lesson plan development training affects

student learning and for the development of future training based on the UDL framework. Studies on UDL lesson plan development used qualitative and quantitative methods. The Williams et al. (2012) study investigated the effect of a UDL online course designed to prepare elementary general education preservice teachers to teach students with disabilities in the inclusive setting. Fifteen preservice teachers participated in the Williams et al. (2012) study, and a self-assessment tool was administered before and after the treatment to investigate the impact UDL lesson plan training had on preservice teachers' perceptions of their ability to develop universally designed lessons. Thirty-six teachers participated in the McGuire-Schwartz and Arndt (2007) study. Qualitative data collection included "focus groups, interviews, a questionnaire, a survey, reviews of lesson plans, document analysis, research notes and memos, and member checks" (McGuire-Schwartz & Arndt, 2007, p. 134). McGhie-Richmond and Sung (2013) examined the changes preservice teachers who had teaching experience through their practicum and practicing teachers made to previously taught lesson plans. Components of 16 preservice and 10 practicing teachers' lesson plans were categorized by the nine UDL guidelines following UDL professional lesson plan development training (McGhie-Richmond & Sung, 2013).

van Kraayenoord et al. (2014) conducted two case studies of school-wide efforts to improve the literacy of students with learning disabilities in inclusive classrooms. CAST conducted case studies of twelve high school general and special education teachers in the inclusive setting who taught standards-based curricula to academically and culturally diverse student populations (Meo, 2008). Dalton and Smith (2012) explored

how 26 elementary school teachers integrated literacy and technology in their design of Internet-based lessons using Strategic Tutor, a tool created by CAST designed to scaffold Internet-based lesson plans. Researchers in the Dalton and Smith (2012) study used qualitative analysis to evaluate teachers' lesson plans.

Spooner et al. (2007) conducted a true pretest/post-test experimental group design with a randomly assigned control group study to investigate the effects of UDL training on preservice teachers' ability to develop universally designed lessons. Seventy-two preservice teachers volunteered to participate in the Spooner et al. (2007) study. Forty-seven teachers from three school districts participated in the Baldiris Navarro et al. (2016) study. Baldiris Navarro et al. (2016) evaluated teachers' lesson plans according to the Spooner et al. (2007) UDL lesson plan scoring rubric to compare mean scores before and after teachers participated in UDL professional development training designed to facilitate the creation of digital-supported universally designed lessons for the inclusive setting. Seventeen teachers from five school districts participated in the current study. Teachers' lesson plans were also evaluated using the Spooner et al. (2007) UDL lesson plan scoring rubric at three time points: (a) before training, (b) immediately after training, and (c) 2 months after the received training to see if teachers had sustained UDL implementation in the lesson design.

UDL Lesson Plan Development Training

The UDL framework is a guide for developing training and curricula that are designed for a specific population and purpose. Although there were differences in each study's UDL lesson plan development training, there were common elements that were

addressed in each intervention. Preservice teachers (McGhie-Richmond & Sung, 2013; McGuire-Schwartz & Arndt, 2007; Spooner et al., 2007; Williams et al., 2012) and in-service teachers (Baldiris Navarro et al., 2016; Meo, 2008; van Kraayenoord et al., 2014) were given examples of universally designed lessons and were taught how to eliminate learning barriers and develop lessons based on UDL principles and guidelines through their teacher preparation coursework or professional development training in each of the UDL lesson plan development studies. McGhie-Richmond and Sung (2013) examined the changes preservice and practicing teachers made to previously taught lesson plans after learning about the broad spectrum of learning disabilities and learner variability. Participants of the study were instructed to revise their lesson plans by first recognizing the physical, cognitive, and social-emotional diversity of the student population the lesson plan was created for; then identify learning barriers that the students may have experienced; and address those barriers by applying UDL to the lesson design (McGhie-Richmond & Sung, 2013).

General education preservice teachers who participated in the Williams et al. (2012) study participated in a course that emphasized the knowledge and skills needed to individualize instruction, provide modifications and accommodations, and design and implement lessons according to the three UDL principles. Students read text about UDL and inclusive classrooms, viewed a video and PowerPoint presentation about constructing universally designed lessons, and were given two examples of UDL lessons (Williams et al., 2012). During guided instruction, they created a case profile of a student and developed UDL strategies that allowed greater access to the standards-based curriculum.

They then collaborated with peers to make improvements to the curricula they developed (Williams et al., 2012). The experimental group in the Spooner et al. (2007) study received a 1-hour training course on how to implement UDL principles in the lesson design. They were given case study examples on how to modify curricula for students with disabilities in the inclusive setting and then asked to develop their examples with the instructor before working independently (Spooner et al., 2007).

Four UDL lesson plan development studies included training that trained teachers on how to implement technology tools in the lesson design (Baldiris Navarro et al., 2016; Dalton & Smith, 2012; Meo, 2008; van Kraayenoord et al., 2014). The training teachers received in the CAST case studies provided a UDL foundation and demonstrated how to incorporate instructional practices and learning materials consistent with UDL principles and guidelines in the lesson design that included: reading comprehension strategies, peer mediated instruction, concept mapping to build background knowledge or activate prior knowledge, preteach vocabulary, inspirational software for brainstorming, and alternative options for assessing student learning that would enable all students to engage in more in depth thinking experience and express their knowledge of content (Meo, 2008).

In the Dalton and Smith (2012) study, teachers were trained on how to design Internet-based lessons using Strategic Tutor, a tool created by CAST designed to scaffold Internet-based lesson plans. The tool provided a medium for integrating multiple means of representation from Internet resources, embedded reading strategies, and support for students' strategic learning processes and ways to express what students have learned

(Dalton & Smith). It guided teachers as they developed goals and activities that could be linked to teacher selected online resources and offered strategic support for reading comprehension strategies and ways for students to respond (Dalton & Smith). A rubric was provided for each of the reading comprehension strategies that teachers could modify for their student population, and an option was also provided for teachers to embed the vocabulary and background knowledge needed to support comprehension (Dalton & Smith, 2012).

Three UDL lesson plan development studies incorporated action research training to guide lesson planning (McGuire-Schwartz & Arndt, 2007; Meo, 2008; van Kraayenoord et al., 2014). Action research is an ongoing analysis of formative and summative assessment data that guides teachers as they make informed decisions about the implementation evidence-based instructional practices that optimize student learning and foster the creation of innovative instruction (Calhoun, 2002). It is important that preservice teachers become knowledgeable about action research to learn how to develop their craft and become innovative agents of change (Ginns, Heirdsfield, Atweh, & Watters, 2001).

In the McGuire-Schwartz and Arndt (2007) study, preservice teachers used multiple qualitative and quantitative action research methods to collect data during their practicum that included observations, pre and post-test student work samples, and reflections of their experience. They first observed diverse learners in the educational setting, then identified barriers in the curriculum, developed strategies using UDL principles and practices, and developed UDL lesson plans during their practicum

(McGuire-Schwartz & Arndt). Preservice teachers also planned and implemented weekly lesson plans for a 6 week unit at an urban after school program during their practicum (McGuire-Schwartz & Arndt, 2007).

In the van Kraayenoord et al. (2014) case studies, teachers engaged in a series of interactive UDL and assistive technology professional development sessions to collaboratively develop new literacy interventions or modify existing ones based on their observations of their students' skills and abilities and standardized assessment data. In the CAST case studies, teachers were trained on how to develop universally designed lessons using a four step circular evaluation process: (a) establish learning context based on students' current level of knowledge and learning goals that are aligned with the standards-based curriculum, (b) identify learning barriers and the appropriate methods, materials, and assessments, (c) implement UDL in the lesson design, and (d) revise lessons based on student outcomes (Meo, 2008).

In the current study, inservice teachers participated in a 10-hour online interactive UDL professional lesson plan development training that provided numerous examples for each of the three UDL principles and exemplars of universally designed lessons. Teachers were able to see that they were already implementing representation, expression, and engagement guidelines in the lesson design. The training was an opportunity for teachers to see the relevance of their current teaching and learning methods and materials, and the opportunity to build upon their existing knowledge. UDL is not about quantity, but the quality of developing conceptual learning experiences that are enhanced through multiple forms of representation, expression, and engagement.

Teachers used the *Characteristics of Diverse Learners* (CAST, 2004), *Examples of UDL Solutions* (CAST, 2004), *Identifying Existing Barriers in the Curriculum Chart* (CAST, 2004), and the UDL guidelines that were applicable for the needs of their student population to create universally designed lessons that would be functional for the context of their classroom and used instructional materials that were available to them.

Summary of the Literature Review

A universally designed lesson is composed of multiple facets. A review of the literature concluded that a variety of teaching and learning methods and materials were needed to accommodate perceptual, processing, and motivation learning differences. When presenting learning content through different modalities, key concepts need to be highlighted to produce a modality effect. To support lower and higher levels of executive functioning, teaching and learning methods and materials should be developmentally appropriate and consist of interactive explicit instruction with exemplars and faded scaffolds to promote independence and allow for leverage, minimize frustration, and sustain motivation. The lesson design should also incorporate resources that supply the background knowledge and prior knowledge needed to fully engage in the standards-based curriculum so students can see the relevance of new information and relationships within and between concepts.

Ongoing formative and summative assessments are needed to guide instruction and to provide constructive feedback to students. For an assessment to be valid, instruction should address all of the learning content covered in the assessment and accommodate the learning needs of the given student population. Although a digital

medium may be better suited for access and participation, prepackaged digital learning environments may not address all of the learning goals needed to accurately assess academic performance. Studies that evaluated digital interventions that were developed with teachers and teacher customized interactive Smartboards that provided AT support were better suited to assess learning outcomes. Students would benefit if teachers used the UDL framework as a guide for lesson planning and instructional design. A review of the literature concluded that student outcomes significantly improved when teachers used the UDL framework to guide lesson planning for diverse student populations in inclusive classrooms.

The literature also showed that inservice and preservice teachers were better prepared to accommodate the academic needs of a diverse student population when UDL lesson plan development training was provided. All of the lesson plan development studies in the review used the UDL framework to develop their studies' interventions. When teachers used an online scaffolding lesson plan tool, they accessed multimodal resources and strategic supports that the tool had to offer. Case studies revealed that teachers successfully eliminated learning barriers and used action research methods to develop curricula for a given student population following UDL training. Comparisons of pre lesson plans and post lesson plans showed an increase for each of the three UDL principles when teachers were trained on how to use the UDL framework as a guide for lesson planning.

Studies conducted on preservice teachers showed that they improved their ability to implement modifications in the lesson design based on UDL principles and guideline

and developed an awareness for academic diversity; however, no follow up studies were conducted when these preservice teachers became teachers. Although these studies showed positive results for general and special education preservice teachers, research has also indicated that preservice teachers did not feel prepared to teach in inclusive classrooms. Studies have shown that many general education instructors do not implement UDL in the curriculum. Some general education instructors believed that UDL was only for special education – promoting exclusion when most students with disabilities spend most of their time in the inclusive setting; furthermore, being unaware of UDL means being unaware of current developments in the fields of cognitive science and educational neuroscience that pertain to teaching and learning.

General education teachers reported that they felt their postsecondary education programs did not prepare them to teach in inclusive classrooms, and that schools did not provide them with the adequate inservice or support needed to meet the demands expected of them. A limited amount of empirical evidence exists on UDL inservice lesson plan development to know if teachers can successfully develop universally designed lessons for their student population using the UDL framework as a guide. Academic diversity exists in every educational setting. If academic diversity is not acknowledged and supported, teachers and students will continue to struggle in mixed-ability classrooms.

Lessons that are aligned with the UDL framework have shown positive outcomes for K – 12 students. Teachers who experienced UDL training and lesson plan development became more aware of student diversity, increased their ability to create

universally designed lessons for their student population, and viewed universally designed lessons as a productive way to communicate content standards to diverse learners. In Chapter 3, I detail the methodology for examining changes in teachers' lesson plans following UDL inservice training.

Chapter 3: Research Method

Introduction

In this chapter, I describe the methodology used and include a description of the quantitative study to examine the changes in teachers' lesson plans (dependent variable) following UDL professional training (independent variable). The following research questions guided the study:

1. Do teachers' lesson plans demonstrate significant change following UDL professional training?

H₀₁: Teachers' lesson plans will not demonstrate significant change following UDL professional training.

H_{a1}: Teachers' lesson plans will demonstrate significant change following UDL professional training.

2. Do teachers' lesson plans demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training?

H₀₂: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training.

H_{a2}: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training.

3. Do teachers' lesson plans demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training?

H₀₃: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training.

H_{a3}: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training.

4. Do teachers' lesson plans demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training?

H₀₄: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training.

H_{a4}: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training.

Chapter 3, I discuss the research design and approach, the setting and sample, instrument and materials, and data collection and analysis for this quantitative study. Also in this chapter, I provide details of the method used to examine the changes in teachers' lesson plans following UDL professional training. A description of the treatment,

instrument for data collection, population and sample, and the procedures that were employed to implement the study are also described in Chapter 3.

Research Design and Approach

To address the research questions, I used a repeated measures design to examine the changes in teachers' lesson plans following UDL professional training. A repeated measures design can show whether there were changes in teachers' lesson plans at various time points after the received training. Lesson plans were evaluated according to the criteria of the UDL lesson plan rubric developed by Spooner et al. (2007). The rubric was used to evaluate teachers' lesson plans at three time points: (a) before training, (b) immediately after training to determine if there were any changes in lesson planning, and (c) 2 months after training to determine if teachers had sustained these changes. Figure 1 illustrates the research design.

O-X-O-O

Figure 1. Repeated measures, within-group design. Adapted from Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (3rd ed.) by J. W. Creswell, 2009, p. 161. Copyright 2009 by SAGE Publications, Inc.

Setting and Sample

The five K–12 study site school districts are located in the state of Mississippi. A convenience sample for the study consisted of teacher volunteers who were evaluated for their ability to design UDL lessons. A description of teacher demographics included gender, degree, years teaching, and certification status.

I e-mailed the district representatives for each of the five school districts in the state of Mississippi the Invitation Letter (Appendix A). The district representatives then

forwarded the Invitation Letter on my behalf to teachers who participated in the 10-hour district-sponsored UDL professional training that I designed. The Invitation Letter contained my e-mail address and indicated that teachers who were interested in participating in this study could contact me directly. Teachers who contacted me were e-mailed the Informed Consent Form and Demographic Request (Appendix B). Teachers who agreed to voluntarily participate in this study replied to the e-mail with the words, “I Consent,” and attached their completed Demographic Request. Participants submitted their lesson plans directly to me at three time points: (a) before training, (b) immediately after training, and (c) 2 months after training.

According to Burkholder (n.d.) in *Sampling Size Analysis for Quantitative Studies*, to determine the sample size for a study the statistical power, alpha, and size effect need to be determined. Burkholder stated:

The accepted value for statistical power, the probability of a treatment effect or relationship, is .80 (80%). It is standard practice to set the alpha at .05, which means that there is only 5% chance that the researcher will arrive at a wrong conclusion and a 95% chance that the conclusions will be correct. (p. 1)

I conducted a power analysis, using G Power 3.1.7 software, to determine the appropriate sample size for this study. Based on results found in the Spooner et al. (2007) study, the mean pre- and post-test scores and average standard deviations for the treatment group ($M = 2.2$, $SD = 1.1$) and control group ($M = .84$, $SD = .98$) were entered into an effect size calculator (Becker, 1999). The following calculations were determined: Cohen's $d = 1.2$ and effect $r = .54$. An a priori power analysis for a repeated-measure, within factors

MANOVA, with three measures, an effect size set at .54 and alpha set at .05, indicated a sample size of 15 participants would be needed to achieve a power of .80. Increasing the sample size to 17 increased power to .88.

Treatment: UDL Lesson Plan Development Training

K–12 teachers from five school districts participated in a 10-hour district-sponsored online UDL professional training session that I designed. Seventeen teachers participated in the study. An accredited CEU granting agency referred by the Mississippi Department of Education evaluated the training. The CEU agency, the Office of Outreach & Innovation of Mississippi University for Women, determined that teachers who participated in the training receive one CEU. The training took place in a Blackboard learning environment. A classroom was created for each of the five school districts. The content of the training was based on cognitive science and neuroscience research that is the foundation for the UDL framework, the UDL framework (principles and guidelines) for lesson planning, and the essential goals of developing universally designed lessons. The goals for the training were as follows:

- to develop flexible curricula with built-in scaffolds and supports that make the standards-based curriculum accessible to diverse learners;
- to learn UDL skills that facilitate turning novice learners into expert learners by developing their metacognitive skills, higher order thinking skills, and basic academic skills as they engage in the learning process;
- to eliminate learning barriers in the environment and allow for optimal learning to occur; and

- to incorporate technology-based and nontechnology-based materials in the lesson design that enhance instruction, engagement, and students' expression of knowledge (CAST, 2011).

Module 1

Participants actively engaged in seven training modules. The Module 1 Presentation addressed the purpose of designing UDL curricula, which is to accommodate academic diversity. The presentation also addressed the benefits of designing UDL curricula for unique student populations, which is to understand learning differences, engage all learners, and eliminate barriers to allow diverse learners greater access to the standards-based curriculum (Hall et al., 2012).

Module 2

The Module 2 Presentation provided detailed instructions for the Blackboard COURSEsites learning environment and informed training participants of training requirements: nine Discussion Boards, three Journal Entries, and three Assignments: Activating Background Knowledge Mini-lesson, *Identifying Existing Barriers in the Curriculum Chart* (CAST, 2004), and UDL lesson plan. Teachers who participated in the training were allowed to use their district lesson plan template to create a universally designed lesson. However, the lesson plan was not used for this study's second data collection; the weekly lesson plan teachers created for their students following training completion was used for the second data collection.

Module 3

The presentation for Module 3 discussed cognitive science and neuroscience and how they pertain to the UDL framework. According to Thagard (2012), learning occurs when students have developed a mental representation of concepts in their minds and understand the conceptual procedures that operate those images. Therefore, students need to engage in conceptual learning that develops knowledge and skills by repeating the cycle at each level of learning (Smolkin & Donovan, 2001). The Module 3 Presentation also addressed “the three brain network functions that pertain to learning-recognition networks, strategic, networks, and affective networks” (CAST, 2011, p. 5). The three brain networks are the basis for the three UDL principles: representation, engagement, and expression (Rose & Meyer, 2002). Individual differences pertaining to the three brain networks were also discussed. Training participants engaged in the following Module 3 Activities:

- Discussion Activity 1--Sharing an Experience: Share an experience you have had as a teacher when students were taught content knowledge (example: multiplication, adjective, vocabulary), but did not retain it.
- Journal Activity 1--Reflecting on Discussion 1 Peer Responses: First read the responses that other teachers have posted for Discussion Activity 1 in the Discussion Board. Do you think that basic academic skills should be taught in isolation, or do you think that students should primarily engage in conceptual learning that develops basic academic skills, content knowledge, and procedural knowledge?

- Discussion Activity 2--UDL Principles and Practice: In the National Center on UDL's (2012a) video, *UDL Principles and Practice*, David Rose explains the three brain networks pertaining to learning and the three UDL principles.

When you have finished watching the video, answer the following question:

What are some the ways the UDL framework can help you develop curricula for diverse learners?

Module 4

The Module 4 Presentation addressed “UDL Principle I: Provide Multiple Forms of Representation” (CAST, 2011, p. 14) and the following UDL Guidelines: “1) Provide options for perception” (CAST, 2011, p. 14); “2) Provide options for language, mathematical expression, and symbols and clarify vocabulary, symbols, syntax, and structure” (CAST, 2011, p. 16); and “3) Provide options for comprehension” (CAST, 2011, p. 18). The first UDL principle supports recognition brain network functions that enable students to identify and interpret patterns through their senses (Rose & Meyer, 2002). The presentation included strategies for representation curriculum development. The flexibility of using digital media for differentiating instruction and creating universally designed lessons was also discussed in the Module 4 Presentation. Module 4 Resources included strategies for activating background knowledge, access to speech-to-text software, inspirational software, software to create video captions, WebQuest resources, and sample lessons.

The Module 4 Activities were:

- Discussion Activity 3--Guidelines in Practice: View the National Center on UDL's (2012b) video, *UDL Guidelines in Practice: Grade 1 Mathematics*. After viewing the video, comment on the ways teachers accommodated the different ways students may perceive information.
- Discussion Activity 4--Providing Options for Perception: Here are four examples of using technology or nontechnology-based materials to provide options for perception:
 - 1) Put different color marbles in a plastic bag to teach probability and fractions.
 - 2) Demonstrate a recipe to teach sequential order and transitional words
 - 3) Use musical notes and instruments to teach fractions.
 - 4) Have students take pictures with a digital camera to retell an event and create an electronic book.

Please provide one or two more suggestions of providing options for perception to share with others.

- Discussion Activity 5--Using Faded Scaffolds to Guide Information Processing: Here are some examples of how to use faded scaffolds to guide information processing: word webs, half-full concept maps, vocabulary words on index cards/key ring to use during writing activities (gradually fade definitions), allow students to use visuals (i.e., measurement charts or grammar rules) until they are able to engage in a conceptual learning

experience independently. Please provide one or two additional examples of using faded scaffolds to guide information processing to share with others.

- Assignment 1-- Mini-Lesson: Activating Prior Knowledge: Use the activating prior knowledge resources to create a mini-lesson to activate or supply prior knowledge and prerequisite concepts before introducing new material to your students using different forms of representation, engagement, and expression. This assignment can be created on a Word document and submitted to the Assignment section. Please be sure to include the materials and how students will engage and express what they have learned in your one paragraph description.
- Journal Activity 2--Reflecting of a Web Quest Learning Environment: Web Quest is a digital UDL teaching and learning tool that enables teachers to create a meaningful technology learning center that engages all learners in a conceptual learning experience. Teacher-selected digital text and media can be easily uploaded along with graphic organizers, quizzes, and learning activities. Select an example of a Web Quest for you content area from the Web Quest resources. After you have done so, post your response to the following question below: How can a WebQuest digital learning environment be more beneficial when designing curricula with multiple forms of representation, engagement, and expression compared to a traditional learning environment that primarily uses lecture to communicate the curriculum, textbooks for engagement, and paper/pencil as a means to express what students know?

Module 5

The Module 5 Presentation addressed “UDL Principle II: Provide Multiple Forms of Action and Expression” (CAST, 2011, p. 22) and the following UDL Guidelines: “4) Provide options for physical action” (CAST, 2011, p. 22), “5) Provide options for expression and communication” (CAST, 2011, p. 23), and “6) Provide options for executive function-supports information processing and planning skills” (CAST, 2011, p. 25). The second UDL principle supports strategic networks functions that allow for planning, task performance, and the organization and expression of ideas through their senses (Rose & Meyer, 2002). The presentation included strategies for action and expression curriculum development. Module 5 Resources included sample lessons, multimedia presentation tools for teachers and students, and access to software for construction and composition (word prediction software and sentence correction software).

Module 5 Activities:

- Discussion Activity 6--UDL Guidelines in Practice: View the National Center on UDL’s (2012c) video, *UDL Guidelines in Practice: Grade 6 Science*. After viewing the video comment on the way teachers allowed for planning, task performance, or the organization of ideas.
- Discussion Activity 7--Options for Physical Action: Here are two examples of providing options for physical action:
 - 1) Speech-to-text software

2) Laminate pictures of an event and place them in sequential order on the floor. Ask a student to retell the event or story as they step in front of each picture.

Share an example of a technology or non-technology based method for providing options for physical action.

- Discussion Activity 8--Enhancing the Capacity for Progress Monitoring:

Here are some examples of enhancing the capacity for monitoring progress: before and after photos, graphs and charts showing progress over time, and portfolio review. What is one example of monitoring progress that you have found to be effective with your students?

Module 6

The Module 6 Presentation addressed “UDL Principle III: Provide Multiple Means of Engagement” (CAST, 2011, p. 28) and the following UDL Guidelines: “(7) Provide options for recruiting interest” (CAST, 2011, p. 28), “(8) Provide options for sustaining effort and persistence” (CAST, 2011, p. 30), and “(9) Provide options for self-regulation” (CAST, 2011, p. 32). The third UDL principle supports affective network functions that pertain to individual differences underlying motivation and engagement (Rose & Meyer, 2002). The presentation included strategies for engagement curriculum development. Module 5 Resources included sample lessons and access to digital resources for collaboration (Wikis and Google Drive).

Module 6 Activities:

- Journal Activity 3--Balancing Structure and Knowing When to be Flexible:
By increasing the predictability of activities and creating a classroom routine, the learning environment becomes less threatening and less distracting to most students. A structured environment can also leave little opportunity for inappropriate behavior. Reflect on an experience when you had to be more flexible than normal (example: allowing students, if needed, extra time to complete an assignment).
- Discussion Activity 9--Rubrics: How can rubrics be used before students begin an assignment to clarify expectations and provide constructive feedback?

Module 7

Module 7 Activities:

- Browse the UDL Resources (n.d.) website and view the National Center on UDL's (2012d) video, *Implementing UDL: The Payoff*. Then, complete End of Training Assignments 1 and 2.
- End of Training Assignment: Use the *Characteristics of Diverse Learners* (CAST, 2004), *Examples of UDL Solutions* (CAST, 2004), *Identifying Existing Barriers in the Curriculum Chart* (CAST, 2004), and the UDL guidelines that are applicable for the needs of your student population to create a universally designed lesson that would allow diverse learners greater access to the standards-

based curriculum. Use your district’s lesson plan template to submit the assignment.

Instrumentation and Materials

The scoring rubric used in the Spooner et al. (2007) study to evaluate participants’ lesson plans, The Scoring Rubric on the Three Components of Universal Design for Learning, was used to evaluate teacher lesson plans in this study. According to Spooner et al. (2007), “The rubric was designed by the investigators and the content validity was measured by an expert panel to determine the degree to which it was representative of the content area” (p. 111). It consists of a 3-point scale, and there is a maximum of 6 points available on the rubric. The rubric reads as follows.

Objective	0 Points	1 Point	2 Points
Representation	No clear description of modifying materials to provide equal access to all students	Discusses one or two modifications of materials to provide equal access, but needs to be explained more in depth	Discusses three or more modifications of materials to provide equal access to all students; gives clear and precise explanations
Expression	No clear description of providing alternative communication methods	Discusses at least one alternative communication method, but needs to be explained more in depth	Discusses two or more alternative communication methods; gives clear and precise explanations
Engagement	No clear description of strategies to involve or engage all students	Discusses one or two strategies to involve all students, but needs to be explained more in depth	Discusses three or more strategies to involve all students; gives clear and precise explanations

Figure 2. The Scoring Rubric on the Three Components of Universal Design for Learning. “Effects of Training in Universal Design for Learning on Lesson Plan Development” by F. Spooner, J. N. Baker, A. A. Harris, L. Ahlgrim-Dezell, and D. M. Browder, 2007, *Remedial and Special Education*, 28(2), p. 112. Copyright 2007 by PRO-ED. Permission was given to reprint the rubric (Appendix C).

Each of the five school districts had teachers use a different lesson plan template to document the lesson that is implemented in their classroom; however, the lesson plan components needed to conduct an evaluation according to The Scoring Rubric on the Three Components of Universal Design for Learning (Spooner et. al, 2007) were provided in each of the five lesson plan templates: Learning Objective(s), Instructional Methods, Procedures and Activities, Materials and Resources, and Assessments/Evaluations. The content of these components were pulled from each of the five school district lesson plan templates into a Standardized Lesson Plan Template (Appendix D) for analysis at each of the three data collection time points.

Validity and Reliability

Shadish, Cook, and Campbell (2002) addressed three principles for quasi-experimental designs: “the research has to enumerate alternative explanations, decide which are plausible, then, use logic, design, and measurement to assess whether each one is operating in a way that might explain the observed effect” (p. 14). Additionally, there are conditions such as ethical concerns, practical issues, and causes of artificially low external validity when people cannot be assigned to randomly assigned conditions (Schatschnieder, 2003). To strengthen the experimental validity of a quasi-experimental design that employs nonprobability sampling, additional constructs must be implemented in the research design (Schatschnieder, 2003).

Internal Validity

Pearl (2000) explained that there may be confounding variables that cannot be controlled in quasi-experimental designs. Confounding factors require additional measures of control in order to strengthen the internal validity of a quasi-experimental design (Pearl, 2000). Johnson and Christensen (2007) argued that a treatment effect is demonstrated in a repeated measure design by discontinuity in the pattern of pretreatment and post-treatment responses. According to Pearl (2000), the potential confounding variables that are a threat to this study's internal validity are instrumentation, testing, treatment, interaction of selection, and history.

Instrumentation. To establish the content validity of an instrument, a panel of experts in the area of interest identify all of the components of the concept that need to be measured (Kimberlin & Winterstein, 2008). Frankfort-Nachmias & Nachmias (2008) explain, "Empirical validity measures the relationship between an instrument and the measured outcomes" (p. 150). This study employed methods that strengthened the construct validity, content validity, and empirical validity by using statistical analysis and controlling the internal and external validity by design (Shadish et al., 2002).

A valid instrument that was used in a previous study was used to evaluate teachers' lesson plans in this study. The content validity of the instrument (Figure 2) "was measured by an expert panel composed of a special education professor with expertise in curriculum adaptation, a math education professor who was experienced in inclusive practices, and a research associate with expertise in research on literacy" (Spooner et al., 2007, p. 111). The researchers designed the rubric, and a panel of experts

determined whether the instrument accurately represented the three UDL principles (Spooner et al., 2007).

Inter-rater agreement. To obtain reliability in data collection for this study, an inter-rater agreement was used to score the lesson plans according to the instrument (Figure 2) for each of the three time points (before the intervention was administered, immediately after the intervention, and 2 months after the intervention was administered). Two raters were used to evaluate the consistency using the same measurement (Kazdin, 1982). I served as one of the raters, and a veteran teacher who develops UDL curricula for her students served as the second rater. To provide evidence that the measurement of the dependent variable was accurate, both raters collected inter-rater agreement data within each condition of the study (Kennedy, 2005).

Inter-rater agreement steps were taken to ensure the validity of the measurement outcomes that were based on criteria Kimberlin and Winterstein (2008) recommended for inter-rater reliability:

Inter-rater reliability is strengthened when raters are trained on how to apply explicit criteria; therefore, raters must be trained on how to make a decision that an event has occurred or how to determine which point on the scale measuring strength should be applied. (p. 3)

I trained the second rater on how to determine points according to the scoring rubric criteria, measuring the strength of the lesson plan according to the three UDL principles. Rater drift can occur when raters begin to change the way they apply the scoring criteria by becoming too lenient or stringent (Kimberlin & Winterstein, 2008). Reliability checks

were conducted throughout the course of data collection to identify when inter-rater reliability began to decline due to rater drift.

According to Vierra and Garret (2005) “Precision of the inter-rater agreement is often reported as a Kappa statistic, which is intended to provide a quantitative measure of the magnitude of agreement between observers” (p. 360). The scale ranges from a negative 1 to a positive 1 (Vierra & Garret, 2005). A positive 1 indicates that raters completely agree on the measurement outcomes observed according to the instrument criteria. A negative value indicates that raters did not agree. Vierra and Garret (2005) recommend using the following Kappa Scale to interpret inter-rater agreement:

Kappa	Agreement
<0	Less than chance agreement
0.01 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 0.99	Almost perfect agreement. (p. 362)

Treatment. The procedural fidelity of the treatment was measured by a district-appointed observer using an observer checklist, Procedural Fidelity Checklist for UDL Training (Appendix E). Wolery (1994) points out, “This method is based on the assumption that if relevant variables are defined, measured, and controlled, then the probability is reduced that some unknown variable or variables would be responsible from the findings that emerge from the investigation” (p. 381). The three principles of

UDL are the foundation for the training design. Therefore, the content of the training was presented in different formats (verbally, text descriptions, videos, and multimedia resources) to accommodate the different learning styles of training participants.

Alternative methods were used for interaction and evaluation that included voice or text responses for discussion forums, journal entries, and assignments.

Interaction of selection. Teachers with various years of teaching experience, degrees, and certification status participated to compensate for interaction of selection. Both male and female teachers participated in the study. Some teachers only had a bachelors degree and others had a masters degree. The number of years teaching participants had ranged from 1 year to 20+ years, and participants had a broad range of teaching certification statuses (elementary education, secondary education, special education, and general education).

History. Participants in this study engaged in the 10-hour online interactive UDL professional training over the course of a two week period during their professional learning community time, and did not engage in any other UDL training sessions throughout the course of the study. The exclusion criteria was documented in the Informed Consent Form and participants agreed to not partake in any other UDL training during the data collection period. The school districts also agreed to not implement any other UDL training.

External Validity

A convenience sample was used for the teacher population in this study. Creswell (2009) explains, “In many quantitative experiments, only a convenience sample is

possible because the researcher must use naturally formed groups” (p. 148). McMillan and Schumacher (2006) described the strengths and limitations for using a convenience sample for a study. This sampling strategy cannot precisely be generalized to any type of population. The generality of the findings are limited to the characteristics of the subjects. McMillan and Schumacher (2006) also note, “Researchers can provide a description of convenient samples to show that although they were not able to use a random sample, the characteristics of the subjects matched those of the population or a substantial portion of the population” (p. 109). Most schools employ teachers with a broad range of characteristics, and schools with similar teacher demographics will be able to identify with the characteristics of the population in this study.

Data Collection and Analysis

A one-way MANOVA with repeated measurement was conducted comparing pretreatment and post-treatment scores for each of the four dependent variables (total score and representation, expression, and engagement scores) to examine changes in teachers’ lesson plans following UDL professional training. Teachers’ lesson plans were evaluated at three time points using the Spooner et al. (2007) lesson plan scoring rubric (Figure 2). Data were collected before the intervention, immediately after the intervention to determine if there were any changes in lesson planning, and 2 months after the intervention was administered to determine if teachers had sustained these changes. The data assumptions for ANOVA/MANOVA repeated-measures read as follows:

1. The dependent variable is normally distributed in the population for each level of within-subject factor;

2. The population variances of different scores computed between any two levels of a within-subjects factor is the same value regardless of which two levels are chosen; and
3. The cases represent a random sample from the population, and there is no dependency in the scores between participants (Green & Salkind, 2011).

The first assumption for the repeated-measures MANOVA was that each variable in the analysis was normally distributed. The Shapiro-Wilk statistic was used to test for normality. To test assumption two, alternative univariate methods were used to correct the degrees of freedom as well as multivariate tests. Although a naturally formed convenience sample was used for this study, assumption three is true for this sample. The only type of dependency that exists among the four dependent variables (total score, representation, expression, and engagement) is the dependency of having one group produce three scores.

The changes in teachers' lesson plans that occurred following UDL professional training were revealed in the within-subject variance of the repeated-measures MANOVA. According to Field (2009), the variance of an experimental treatment consists of the treatment effect and individual differences in performance; therefore, it is reasonable to conclude that higher post-treatment scores compared to pretreatment scores would occur due to the treatment and not by chance. All participants were evaluated under the same three conditions; therefore, any variance that cannot be explained by the treatment would be due to random factors not related to the treatment (Field, 2009).

Protection of Participants' Rights

Walden University's Instructional Review Board granted permission to conduct the study (#07-22-15-0180609). To ensure confidentiality, the names of participants are not revealed, nor are the names of the school districts where the study was conducted. Only mean scores of evaluated teacher lesson plans according to the measurement instrument and teacher demographics are displayed. The data from each experimental condition were collected and coded before they were analyzed by the inter-rater to protect the confidentiality of teachers and the district. All e-mail correspondences between the researcher and inter-rater were password protected to ensure privacy.

Participation in this study was on a volunteer basis. Participants were required to sign a consent form informing them of their rights. The following information was included in the consent form: the study's purpose, background information, procedures, voluntary nature, risks and benefits, confidentiality, compensation, and contact information. The consent form was written in language that potential study participants could easily understand.

Steps were taken to protect the privacy and confidentiality of study participants and the five school districts by coding the data. Data were stored on a Compact Disc (CD) and put in a safety deposit box at a bank. I am the only one who has access. The data will be kept in the safety deposit box for 5 years. After 5 years, data will be deleted and the CD will be destroyed and discarded.

Summary of Methodology

Chapter 3 contained details of the research design and methodology for examining changes in lesson planning following UDL professional training. I used a repeated measures design to examine the changes in teachers' lesson plans following the treatment. Lesson plans were evaluated according to the criteria of the UDL lesson plan rubric developed by Spooner et al. (2007) at three time points. A convenience sample for the study consisted of 17 teacher volunteers who were evaluated for their ability to design UDL lessons. A one-way MANOVA with repeated measurement was conducted comparing pretreatment and post-treatment scores. The setting, treatment, and the protection of participants' privacy and identity were also discussed in this chapter. I present the results of the research question and overall outcome of the study in Chapter 4.

Chapter 4: Results

Introduction

The purpose of this quantitative study was to examine the changes in teachers' lesson plans (dependent variable) following UDL professional training (independent variable) in order to help teachers become more aware of diversity in learning and learn how to implement UDL in the lesson design. In this chapter, I describe the data collection procedures, demographic characteristics of the sample, treatment fidelity, and inter-rater agreement. Procedures for cleaning and screening the data included tests of normality, and the assumptions for the repeated measures MANOVA are also evaluated in the chapter. Results of the statistical analysis were reported in relation to the research questions and hypotheses.

Data Collection

The first lesson plan was collected before teachers started the training, and the second lesson plan was collected after teachers completed the training. The third lesson plan was collected 2 months after teachers completed the training. Each of the five school districts started and completed the training at different time points from August 2015 to October 2015. This flexible timeframe was allotted to accommodate each district's schedule.

Teachers independently engaged in the online interactive training environment during their hourly Professional Learning Communities (PLC) time each day over the course of a 2 to 4 week period. I monitored training participation in the Blackboard COURSEsites training environment to validate completion of training requirements and

start and completion dates. Special educators needed longer than 2 weeks to complete the training, because they needed to be trained on new IEP forms and procedures. Some were delayed in completing the training due to technical problems; others encountered unexpected parent-teacher conferences. Although teachers needed additional time to complete the training due to their normal duty requirements, at no time throughout the course of the study did teachers engage in any other UDL training.

Demographics of Participants

Twenty-one teachers signed the Informed Consent Form, but only 17 teachers participated in the study. The sample consisted of one male (6%) and 16 females (94%). Seven of the 17 study participants had a masters degree (41%). Three participants had 1–5 years teaching experience (18%), two had 6–10 years (12%), three had 11–15 years (18%), five had 15–20 years (29%), and four had 20+ years (23%). Two of the participants were elementary general educators (12%), one was a secondary general educator (6%), six were elementary special educators (35%), and eight were secondary special educators (47%). Although a convenience sample was used for this study, most school districts employ teachers with a broad range of demographics and teaching certifications to accommodate their curricula and student population.

Treatment Fidelity

The district representatives from each of the five school districts evaluated the 10-hour online interactive UDL professional development training by completing the Procedural Fidelity Checklist for UDL Training (Appendix E). All five district representatives agreed (100%) that the training presented information in a variety of ways

to address participant diversity. They also agreed that the training provided alternative ways to interact with content, used methods and techniques that are pedagogically effective for all, and used multiple means of evaluation (CAST, 2004).

Inter-rater Agreement

To obtain reliability in data collection for this study, an inter-rater agreement was used to score the lesson plans according to the instrument (Figure 2) for each of the three data collection time points. Viera and Garret (2005) stated:

Precision of the inter-rater agreement is often reported as a Kappa statistic, which is intended to measure agreement between observers; the calculation is based on the difference between how much agreement is present compared to how much agreement would be expected to be present by chance alone by calculating the percentage of agreement for all observations. (p. 360)

In this study, raters independently agreed 100% of the time for all observations.

Reliability checks were conducted mid-way through data scoring for each of the three data collection time points to prevent rater drift.

Results

Descriptive Statistics

Means and standard deviations for each of the four dependent variables (representation, expression, engagement, and total score) and three levels of data collection: (a) before the received UDL training, (b) immediately after the received UDL training, and (c) 3 months after the received UDL training are presented in Table 1. Participants' lesson plans were evaluated according to the scoring rubric (Figure 2), and a

score was determined for each of the four dependent variables at each of the three levels of data collection. The scoring rubric consists of a 3-point scale (0 points, 1 point, and 2 points) that is used to determine a score for each of the three UDL principles: representation, expression, and engagement. There is a maximum of 6 points possible (2 points for each of the three UDL principles) that is used to determine a total score.

The means score for each of the four dependent variables increased from the first data set to the second: Representation 1 ($M = 1.41$) – Representation 2 ($M = 2.00$), Expression 1 ($M = 1.59$) – Expression 2 ($M = 2.00$), Engagement 1 ($M = .59$) – Engagement 2 ($M = 1.59$), and Total Score 1 ($M = 3.59$) – Total Score 2 ($M = 5.59$). However, the mean scores from the second data set to the third stayed relatively the same: Representation 2 ($M = 2.00$) – Representation 3 ($M = 2.00$), Expression 2 ($M = 2.00$) – Expression 3 ($M = 2.00$), Engagement 2 ($M = 1.59$) – Engagement 3 ($M = 1.47$), and Total Score 2 ($M = 5.59$) – Total Score 3 ($M = 5.47$). The increase in mean scores from the first data set to the second indicated that teachers implemented more UDL components in the lesson design after participating in the UDL professional development training. Similar mean scores from the second data set to the third indicated that teachers had sustained UDL implementation in the lesson design 2 months after the received training.

Minimum scores for Representation, Expression, and Total Score increased from the first data set to the second and third, indicating that teachers benefited in regard to UDL implementation in the lesson design from the received training. However, minimum Engagements scores did not increase from the first data set to the second and third, which

may indicate that some teachers need additional training for implementing UDL engagement components. Maximum scores for Engagement and Total Score increased from the first data set to the second. However, maximum Representation and Expression scores did not change, which may indicate that some teachers were skilled at implementing UDL representation and expression components in the lesson design prior to the received training.

Table 1

Descriptive Statistics for Each of the Four Dependent Variables

	<i>N</i>	Minimum	Maximum	<i>M</i>	<i>SD</i>
Representation 1	17	1	2	1.41	.507
Representation 2	17	2	2	2.00	.000
Representation 3	17	2	2	2.00	.000
Expression 1	17	0	2	1.59	.618
Expression 2	17	2	2	2.00	.000
Expression 3	17	2	2	2.00	.000
Engagement 1	17	0	1	.59	.507
Engagement 2	17	0	2	1.59	.712
Engagement 3	17	0	2	1.47	.624
Total Score 1	17	2	5	3.59	1.121
Total Score 2	17	4	6	5.59	.712
Total Score 3	17	4	6	5.47	.624
Valid <i>N</i> (listwise)	17				

Note. *N* = 17 for all measures

Total Score Tests of Hypotheses

A repeated measures MANOVA procedure with an alpha level of .05 ($p = .05$) was used to test hypotheses for the assumption of normality. Hypotheses 1 predicted that teachers' lesson plans would significantly change following UDL professional training:

H₀1: Teachers' lesson plans will not demonstrate significant change following UDL professional training.

H_a1: Teachers' lesson plans will demonstrate significant change following UDL professional training.

Table 2

Mauchly's Test of Sphericity for Total Score

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Total Score	.757	4.176	2	.124	.804	.881	.500

Note. b. Design Intercept Within Subjects Design: Total Score

Table 2 shows the results of Mauchly's test of sphericity. Mauchly's test indicated that the assumption of sphericity had not been violated $X^2(2) = 4.18, p = .124$. The variances of differences between the three conditions were relatively equal. According to Field (2009), the power of Mauchly's test depends on the sample size" (p. 460). The sample size for this study was 17. In small sample sizes, large violations from sphericity may be interpreted as nonsignificant (Field, 2009). To further test the assumption, Table 3 shows alternative univariate methods conducted to correct the degrees of freedom as well as multivariate tests.

Table 3

Tests of Within-Subjects Effects for Total Score

	Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
Total Score	Sphericity Assumed	42.824	2	21.412	45.147	.000
	Greenhouse-Geisser	42.824	1.609	26.615	45.147	.000
	Huynh-Feldt	42.824	1.762	24.308	45.147	.000
	Lower-bound	42.824	1.000	42.824	45.147	.000
Error (Total Score)	Sphericity Assumed	15.176	32	.474		
	Greenhouse-Geisser	15.176	25.744	.590		
	Huynh-Feldt	15.176	28.187	.538		
	Lower-bound	15.176	16.000	.949		

Table 3 shows the results of the ANOVA with corrected *F* values. The significant values indicated that there was a significant difference in teachers' lesson plans between the three conditions, Greenhouse-Geisser ($p < .05$) and Huynh-Feldt ($p < .05$). The one way within-subjects repeated measures ANOVA results in Table 4 were interpreted using multivariate tests; therefore, avoiding the controversy surrounding the sphericity assumption (Green & Salkind, 2011).

Table 4

Multivariate Tests for Total Score

Effect	Value	<i>F</i>	Hypothesis <i>df</i>	Error <i>df</i>	Sig.
Pillai's Trace	.795	29.150 ^b	2.000	15.000	.000
Total Wilks' Lambda	.205	29.150 ^b	2.000	15.000	.000
Score Hotelling's Trace	3.887	29.150 ^b	2.000	15.000	.000
Roy's Largest Root	3.887	29.150 ^b	2.000	15.000	.000

b. Design Intercept Within Subjects Design: Total Score

Each of the four multivariate tests in Table 4 tested the multivariate effect of the Total Score. The tests indicated a significant multivariate effect for the combined dependent variables of Representation, Expression, and Engagement $WILKS's\ lambda = .21, F(2,15) = 29.15, p < .05$. Wilks' lambda is commonly used among social science researchers to test whether there are differences between the means of each condition (Everitt & Dunn, 1991). However, these tests do not determine which of the three levels differs from the other: Level 1 = before UDL professional training, Level 2 = immediately after training, and Level 3 = 2 months after training. Pairwise comparison and tests of within-subjects contrast shown in Table 5 were conducted for the Total Score dependent variable to determine which level differed from the other.

Table 5

Pairwise Comparisons for Total Score

(I) Total Score	(J) Total Score	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	-2.000*	.257	.000	-2.688	-1.312
	3	-1.882*	.270	.000	-2.603	-1.162
2	1	2.000*	.257	.000	1.312	2.688
	3	.118	.169	1.000	-.334	.569
3	1	1.882*	.270	.000	1.162	2.603
	2	-.118	.169	1.000	-.569	.334

Note. Based on estimated marginal means

*The mean difference is significant at the .05 level.

*Adjustment for multiple comparisons: Bonferroni.

b. Design Intercept Within Subjects Design: Total Score

The results of the pairwise comparison for Total Score are shown in Table 5, “controlling for familywise error rate across the tests at the .05 level using the Holm’s sequential Bonferroni procedure” (Green & Salkind, 2011, p. 237). The comparison between Total Score Level 1 and 2 and Total Score Level 1 and 3 were significant ($p < .05$), indicating a change in teachers’ lesson plans following UDL professional training. However, there was not a significant difference between Total Score Level 2 and 3 ($p = 1.00$), indicating that teachers had sustained UDL implementation in the lesson design two months after the received training. Table 6 shows the results of further tests that were conducted to determine which level indicated a significant change in teachers’ lesson plans.

Table 6

Tests of Within-Subjects Contrasts for Total Score

Source	Total Score	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
Total	Level 1 vs. Level 2	68.000	1	68.000	60.444	.000
Score	Level 2 vs. Level 3	.235	1	.235	.485	.496
Error	Level 1 vs. Level 2	18.000	16	1.125		
(Total Score)	Level 2 vs. Level 3	7.765	16	.485		

The results of the repeated measures contrast for Total Score are shown in Table 6. There was a significant Total Score effect from Level 1 to Level 2 $F(1,16) = 68.00$, $p < .05$, indicating a change in teachers' lesson plans. However, there was not a significant difference or change in teachers' lesson plans from Level 2 to Level 3 $F(1,16) = .24$, $p = .496$.

The within subjects repeated-measures MANOVA results supported the decision to accept H_{a1} . Teachers' lesson plans significantly changed following UDL professional training. Therefore, H_01 , predicting teachers' lesson plans would not change following UDL professional development training, was rejected.

Representation Hypotheses Testing

Hypothesis 2 predicted that teachers' lesson plans would significantly change in the level of application of the UDL guiding principle of representation following UDL professional training:

H₀2: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training.

H_a2: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training.

Table 7

Mauchly's Test of Sphericity for Representation

Within Subjects Effect	Mauchly's W	Approx . Chi-Square	df	Sig.	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Representation	.000	.	2	.	.500	.500	.500

Note. b. Design Intercept Within Subjects Design: Representation

Table 7 shows the results of Mauchly's test for the Representation dependent variable. A significant value was not produced. Therefore, there was no way of knowing if the variances between the three conditions were relatively equal. To test the assumption, alternative univariate methods shown in Table 8 were also conducted to correct the degrees of freedom as well as multivariate tests.

Table 8

Tests of Within-Subjects Effects for Representation

Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.	
Representation	Sphericity Assumed	3.922	2	1.961	22.857	.000
	Greenhouse-Geisser	3.922	1.000	3.922	22.857	.000
	Huynh-Feldt	3.922	1.000	3.922	22.857	.000
	Lower-bound	3.922	1.000	3.922	22.857	.000
Error (Representation)	Sphericity Assumed	2.745	32	.086		
	Greenhouse-Geisser	2.745	16.000	.172		
	Huynh-Feldt	2.745	16.000	.172		
	Lower-bound	2.745	16.000	.172		

Table 8 shows the results of the ANOVA with corrected *F* values. The significant values indicated that there was a significant Representation difference in teachers' lesson plans between the three conditions, Greenhouse-Geisser ($p < .05$) and Huynh-Feldt ($p < .05$). Table 9 shows the MANOVA output for the Representation dependent variable.

Table 9

Multivariate Tests of Representation

	Value	<i>F</i>	Hypothesis <i>df</i>	Error <i>df</i>	Sig.
Pillai's trace	.588	22.857 ^a	1.000	16.000	.000
Wilks' lambda	.412	22.857 ^a	1.000	16.000	.000
Hotelling's trace	1.429	22.857 ^a	1.000	16.000	.000
Roy's largest root	1.429	22.857 ^a	1.000	16.000	.000

Note. a. exact statistic

Each of the four multivariate tests in Table 9 tested the multivariate effect of the Representation variable. The tests indicated a significant multivariate effect for Representation $WILKS'S\ lambda = .41, F(1,16) = 22.86, p < .05$. Pairwise comparison and tests of within-subjects contrast shown in Table 10 were conducted for Representation to determine which level differed from the other.

Table 10

Pairwise Comparisons for Representation

(I) Representation	(J) Representation	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	-.588*	.123	.001	-.917	-.259
	3	-.588*	.123	.001	-.917	-.259
2	1	.588*	.123	.001	.259	.917
	3	.000	.000	.	.000	.000
3	1	.588*	.123	.001	.259	.917
	2	.000	.000	.	.000	.000

Note. Based on estimated marginal means

*The mean difference is significant at the .05 level.

*Adjustment for multiple comparisons: Bonferroni.

b. Design Intercept Within Subjects Design: Representation

The results of the pairwise comparison for Representation are shown in Table 10. The comparison between Representation Level 1 and 2 and Representation Level 1 and 3 were significant ($p = .001$). However, there was not a mean difference between Representation 2 ($M = 2.00$) and Representation 3 ($M = 2.00$); therefore, a value was not

produced. Table 11 shows the results of further tests that were conducted to determine which level indicated a significant change in teachers' lesson plans.

Table 11

Tests of Within-Subjects Contrasts for Representation

Source	Representation	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
Representation	Level 1 vs. Level 2	5.882	1	5.882	22.857	.000
	Level 2 vs. Level 3	.000	1	.000	.	.
Error (Representation)	Level 1 vs. Level 2	4.118	16	.257		
	Level 2 vs. Level 3	.000	16	.000		

The results of the repeated measures contrast for Representation are shown in Table 11. There was a significant Representation effect from Level 1 to Level 2 $F(1,16) = 22.86, p = .00$, indicating a change in teachers' lesson plans. However, there was not a mean difference between Representation 2 ($M = 2.00$) and Representation 3 ($M = 2.00$); therefore, a value was not produced.

These tests supported the decision to accept H_a2 . Teachers' lesson plans significantly changed in the level of application of the UDL guiding principle of representation following UDL professional training. Therefore, Null H_02 , predicting teachers' lesson plans would not demonstrate significant change in the level of application of the UDL guiding principle of representation following UDL professional training, was rejected.

Expression Hypotheses Testing

Hypothesis 3 predicted that teachers' lesson plans would significantly change in the level of application of the UDL guiding principle of expression following UDL professional training:

H₀3: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training.

H_a3: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training.

Table 12

Mauchly's Test of Sphericity for Expression

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Expression	.000	.	2	.	.500	.500	.500

Note. b. Design Intercept Within Subjects Design: Expression

Table 12 shows the results of Mauchly's test for the Expression dependent variable. A significant value was not produced. Therefore, there was no way of knowing if the variances between the three conditions were relatively equal. To test the assumption, alternative univariate methods shown in Table 13 were also conducted to correct the degrees of freedom as well as multivariate tests.

Table 13

Tests of Within-Subjects Effects for Expression

Source		Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
Expression	Sphericity Assumed	1.922	2	.961	7.538	.002
	Greenhouse-Geisser	1.922	1.000	1.922	7.538	.014
	Huynh-Feldt	1.922	1.000	1.922	7.538	.014
	Lower-bound	1.922	1.000	1.922	7.538	.014
Error (Expression)	Sphericity Assumed	4.078	32	.127		
	Greenhouse-Geisser	4.078	16.000	.255		
	Huynh-Feldt	4.078	16.000	.255		
	Lower-bound	4.078	16.000	.255		

Table 13 shows the results of the ANOVA with corrected *F* values. The significant values indicated that there was a significant Expression difference in teachers' lesson plans between the three conditions, Greenhouse-Geisser ($p = .014$) and Huynh-Feldt ($p = .014$). Table 14 shows the MANOVA output for the Expression dependent variable.

Table 14

Multivariate Tests of Expression

	Value	<i>F</i>	Hypothesis <i>df</i>	Error <i>df</i>	Sig.
Pillai's trace	.320	7.538 ^a	1.000	16.000	.014
Wilks' lambda	.680	7.538 ^a	1.000	16.000	.014
Hotelling's trace	.471	7.538 ^a	1.000	16.000	.014
Roy's largest root	.471	7.538 ^a	1.000	16.000	.014

Note. a. exact statistic

The multivariate tests in Table 14 indicated a significant Expression effect $WILKS'S\ lambda = .68, F(1,16) = 7.54, p = .014$. Pairwise comparison and tests of within-subjects contrast shown in Table 15 were conducted for the dependent variable of Expression. These tests were conducted to determine which level differed from the other.

Table 15

Pairwise Comparisons for Expression

(I) Expression	(J) Expression	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	-.412 [*]	.150	.043	-.813	-.011
	3	-.412 [*]	.150	.043	-.813	-.011
2	1	.412 [*]	.150	.043	.011	.813
	3	.000	.000	.	.000	.000
3	1	.412 [*]	.150	.043	.011	.813
	2	.000	.000	.	.000	.000

Note. Based on estimated marginal means

*The mean difference is significant at the .05 level.

* Adjustment for multiple comparisons: Bonferroni.

b. Design Intercept Within Subjects Design: Expression

The results of the pairwise comparison for Expression are shown in Table 15. The comparison between Expression Level 1 and 2 and Expression Level 1 and 3 were significant ($p = .043$). However, there was not a mean difference between Expression 2 ($M = 2.00$) and Expression 3 ($M = 2.00$); therefore, a value was not produced. Table 16 shows the results of further tests that were conducted to determine which level indicated a significant change in teachers' lesson plans.

Table 16

Tests of Within-Subjects Contrasts for Expression

Source	Expression	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
Expression	Level 1 vs. Level 2	2.882	1	2.882	7.538	.014
	Level 2 vs. Level 3	.000	1	.000	.	.
Error (Expression)	Level 1 vs. Level 2	6.118	16	.382		
	Level 2 vs. Level 3	.000	16	.000		

The results of the repeated measures contrast for Expression are shown in Table 16. There was a significant Expression effect from Level 1 to Level 2 $F(1,16) = 7.54$, $p = .014$, indicating a change in teachers' lesson plans. However, there was not a mean difference between Expression 2 ($M = 2.00$) and Expression 3 ($M = 2.00$); therefore, a value was not produced.

These tests supported the decision to accept H_a3 . Teachers' lesson plans significantly changed in the level of application of the UDL guiding principle of expression following UDL professional training. Therefore, H_03 , predicting teachers'

lesson plans would not demonstrate significant change in the level of application of the UDL guiding principle of expression following UDL professional training, was rejected.

Engagement Hypotheses Testing

Hypothesis 4 predicted that teachers' lesson plans would significantly change in the level of application of the UDL guiding principle of engagement following UDL professional training:

H₀4: Teachers' lesson plans will not demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training.

H_a4: Teachers' lesson plans will demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training.

Table 17

Mauchly's Test of Sphericity for Engagement

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Engagement	.962	.575	2	.750	.964	1.000	.500

Note. b. Design Intercept Within Subjects Design: Total Score

Table 17 shows the

results of Mauchly's test of sphericity. Mauchly's test indicated that the assumption of sphericity had not been violated $X^2(2) = .575, p = .750$. The variances of differences between the three conditions were relatively equal. The sample size for this study was 17. In small sample sizes, large violations from

sphericity may be interpreted as nonsignificant (Field, 2009). To further test the assumption, alternative univariate methods shown in Table 18 were conducted to correct the degrees of freedom as well as multivariate tests.

Table 18

Tests of Within-Subjects Effects for Engagement

	Source	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
	Sphericity Assumed	10.157	2	5.078	24.964	.000
Engage- ment	Greenhouse-Geisser	10.157	1.928	5.269	24.964	.000
	Huynh-Feldt	10.157	2.000	5.078	24.964	.000
	Lower-bound	10.157	1.000	10.157	24.964	.000
Error (Engage- ment)	Sphericity Assumed	6.510	32	.203		
	Greenhouse-Geisser	6.510	30.841	.211		
	Huynh-Feldt	6.510	32.000	.203		
	Lower-bound	6.510	16.000	.407		

Table 18 shows the results of the ANOVA with corrected *F* values. The significant values indicated that there was a significant difference in teachers' lesson plans between the three conditions, Greenhouse-Geisser ($p < .05$) and Huynh-Feldt ($p < .05$). Table 19 shows the MANOVA output for the Engagement dependent variable.

Table 19

Multivariate Tests of Engagement

	Value	<i>F</i>	Hypothesis <i>df</i>	Error <i>df</i>	Sig.
Pillai's trace	.793	28.788 ^a	2.000	15.000	.000
Wilks' lambda	.207	28.788 ^a	2.000	15.000	.000
Hotelling's trace	3.838	28.788 ^a	2.000	15.000	.000
Roy's largest root	3.838	28.788 ^a	2.000	15.000	.000

Note. a. exact statistic

The multivariate tests in Table 19 indicated a significant Engagement effect $WILKS'S\ lambda = .21, F(2,15) = 28.89, p < .05$. Pairwise comparison and tests of within-subjects contrast shown in Table 20 were conducted for the dependent variable of Engagement to determine which level differs from the other.

Table 20

Pairwise Comparisons of Engagement

(I) ENG	(J) ENG	Mean Differenc e (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	-1.000*	.149	.000	-1.397	-.603
	3	-.882*	.146	.000	-1.271	-.493
2	1	1.000*	.149	.000	.603	1.397
	3	.118	.169	1.000	-.334	.569
3	1	.882*	.146	.000	.493	1.271
	2	-.118	.169	1.000	-.569	.334

Note. Based on estimated marginal means

*The mean difference is significant at the .05 level.

*Adjustment for multiple comparisons: Bonferroni.

b. Design Intercept Within Subjects Design: Engagement

The results of the pairwise comparison for Engagement are shown in Table 20.

The comparison between Engagement Level 1 and 2 and Engagement Level 1 and 3 were significant ($p < .05$). However, there was not a significant difference between Engagement Level 2 and 3 ($p = 1.00$), indicating that teachers had sustained the UDL principle of engagement in the lesson design two months after the received training.

Table 21 shows the results of further tests that were conducted to determine which level indicated a significant change in teachers' lesson plans.

Table 21

Tests of Within-Subjects Contrasts for Engagement

Source	Engagement	Type III Sum of Squares	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
Engagement	Level 1 vs. Level 2	17.000	1	17.000	45.333	.000
	Level 2 vs. Level 3	.235	1	.235	.485	.496
Error (Engagement)	Level 1 vs. Level 2	6.000	16	.375		
	Level 2 vs. Level 3	7.765	16	.485		

The results of the repeated measures contrast for Engagement are shown in Table 13. There was a significant Engagement effect from Level 1 to Level 2 $F(1,16) = 45.33, p < .05$, indicating a change in teachers' lesson plans. However, there was not a significant Engagement difference or change in teachers' lesson plans from Level 2 to Level 3 $F(1,16) = .49, p = .50$.

These tests supported the decision to accept H_{a4} . Teachers' lesson plans significantly changed in the level of application of the UDL guiding principle of engagement following UDL professional training. Therefore, H_{04} , predicting teachers'

lesson plans would not demonstrate significant change in the level of application of the UDL guiding principle of engagement following UDL professional training, was rejected.

Summary of the Results

Repeated measures MANOVAs were conducted in order to examine the changes in teachers' lesson plans following UDL professional training. In order to test the hypotheses using MANOVA, multivariate test values were used to test for normality. The multivariate tests showed a significant effect for each of the four dependent variables (representation, expression, engagement, and total score). Pairwise comparisons between the first data set and the second data set and first and third were significant; however, there was no significant difference between the second data set and third data set, indicating that teachers had sustained UDL implementation in the lesson design 2 months after the received training. The results of the repeated measures contrast also showed a significant effect from the first data set to the second data set and no significant difference from the second to the third. The MANOVA results indicated that teachers had increased their use of UDL principles in the lesson design after the received training and sustained UDL implementation 2 months after the received training. In Chapter 5, I will provide an interpretation of the data analysis in this chapter and will use the results in making further recommendations for research and implications for social change.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quasi-experimental study was to examine teachers' lesson plans following a 10-hour online interactive UDL professional training that I designed based on the UDL framework. The training was implemented in five school districts in the state of Mississippi. Seventeen teachers voluntarily participated in the study. A one-way MANOVA with repeated measurement was conducted comparing pretreatment and post-treatment scores for each of the four dependent variables (Total Score and Representation, Expression, and Engagement scores). Teachers' lesson plans were evaluated at three time points using the Spooner et al. (2007) lesson plan scoring rubric (see Figure 2). Data were collected before the intervention, immediately after the intervention to determine if there were any changes in lesson planning, and 2 months after the intervention was administered to determine if teachers had sustained these changes. The results of the analysis showed a significant difference in teachers' lesson plans between conditions for each of the four dependent variables.

Summary of Key Findings

In the analysis of the research questions, I focused on examining teachers' lesson plans from Level 1 (before UDL professional training) to Level 2 (immediately after training) and Level 3 (2 months after the received training) on four dependent variables based on the three UDL principles (Representation, Expression, and Engagement) to determine a score for each dependent variable using the UDL lesson plan scoring rubric

(Figure 2). A Total Score of the three dependent variables were combined to create the total instrument score.

Data analysis measures included Mauchly's test of sphericity, ANOVA tests of within-subjects effect, multivariate tests, descriptive statistics, pairwise comparison, and within-subjects contrast. The assumption requirements for the one-way repeated measures ANOVA/MANOVA were met. ANOVA tests of within-subjects effect and multivariate tests showed that there was a significant difference in teachers' lesson plans between conditions for each of the four dependent variables. Post hoc tests revealed that this significance was between Levels 1 (before training) and 2 (after training), and Levels 1 and 3 (2 months later). There was no significant difference between Levels 2 and 3. An examination of the means for each of the four dependent variables also showed an increase from Levels 1 to 2, and similar mean scores from Levels 2 to 3.

Interpretation of Findings

In this study, I sought to examine the changes in teachers' lesson plans following UDL professional training. ANOVA within-subject effect tests and multivariate tests were significant for each of the four variables (Total Score, Representation, Expression, and Engagement), indicating a change in teachers' lesson plans between conditions: Level 1 (before training), Level 2 (after training), and Level 3 (2 months later). Post hoc tests showed that the significant changes occurred in teachers' lesson plans from Level 1 to Level 2 and from Level 1 to Level 3, indicating that teachers benefited from the received training. There were no significant changes from Level 2 to Level 3, indicating that teachers had sustained UDL implementation in the lesson design 2 months

after the received training. To further support the analysis of significant changes in teachers' lesson plans after the received training and sustainability of UDL in the lesson design 2 months after the training, within-subject contrasts also revealed that significant changes occurred in teachers' lesson plans from Level 1 to Level 2 and that there were no significant changes from Level 2 to Level 3.

For this sample of practicing teachers, findings of changes in teachers' lesson plans were consistent with existing research on UDL lesson plan development training with preservice teachers (McGhie-Richmond & Sung, 2013; McGuire-Shwartz & Arndt, 2007; Spooner et al., 2007; Williams et al., 2012) and inservice teachers (Baldiris Navarro et al., 2016; Dalton & Smith, 2012; Meo, 2008; van Kraayenoord et al., 2014). Inservice teachers in the current study and preservice and inservice teachers in previous studies demonstrated their ability to develop universally designed lessons for a given student population following UDL lesson plan development training based on the UDL framework.

Total Score Interpretation

The Total Score mean (see Table 1) increased after the received training. The mean score stayed relatively the same 2 months after the training, indicating that most teachers had sustained UDL implementation in the lesson design 2 months after the received training. Researchers in previous UDL lesson plan development studies analyzed lesson plans according to the three UDL principles as I did in this study. However, of the eight studies conducted on UDL lesson plan development, only four reported findings for Principle III. A Total Score analysis of the combined three

principles was not reported in any of these studies. Therefore, significant findings and Total Score means from this study could not be compared to previous studies on UDL lesson plan development.

Representation Score Interpretation

The results of this study showed a significant change in teachers' lesson plans in the level of application of UDL Principle I following UDL professional lesson plan development training that is consistent with existing research. The Spooner et al. (2007) study also showed a significant within-subject representation pretest/post-test effect ($p < .001$). UDL training increased preservice teachers' ability to implement representation guidelines in the lesson design as this study did for inservice teachers.

The means for the Representation score (see Table 1) in this study increased from Level 1 to Level 2, indicating that teachers' lesson plans had changed following UDL professional training. The mean score from Level 2 to Level 3 did not change, indicating that most teachers had sustained UDL implementation in the lesson design 2 months after the received training. The results of the Spooner et al. (2007) study also showed an increase in preservice teachers' mean scores for the representation dependent variable between experimental pretest/post-test scores when compared to control group pretest/post-test scores. Inservice teachers from each of the three school districts participating in the Baldiris Navarro et al., (2016) study also demonstrated a considerable amount of growth for representation when pretest/post-test mean scores were compared. All of these studies used the same UDL lesson plan scoring instrument to evaluate teachers' lesson plans. However, the Spooner et al. (2007) and Baldiris Navarro et al.,

(2016) studies did not indicate which of the three UDL guidelines or teaching and learning methods for each of the three UDL principles were implemented in the lesson design.

Teachers in this study implemented each of the three Principle I guidelines in the lesson design following UDL lesson plan development training based on the UDL framework: Guideline 1 – presenting information through different modalities; Guideline 2 – preteaching vocabulary, making connections within and between concepts using visual representations, and illustrating through technology and nontechnology-based multimedia; and Guideline 3 – activating prior knowledge, highlighting key concepts, and visually supporting information processing (CAST, 2011). Additional research also found that teachers increased Principle I guidelines in the lesson design following UDL lesson plan development training based on the UDL framework. However, there were a few differences in the implementation of the three Principle I guidelines for preservice teachers and practicing teachers. Both preservice and inservice teachers implemented Guideline 1 in the McGhie-Richmond and Sung (2013) study. Preservice teachers made more revisions for Guideline 3 and less for Guideline 2 than practicing teachers (McGhie-Richmond & Sung, 2013). Teachers participating in the CAST case studies (Meo, 2008) implemented the three UDL representation guidelines by engaging students in brainstorming activities using inspirational software, concept mapping to activate prior knowledge, and vocabulary instruction to support comprehension.

Teachers in this study implemented more graphic organizers in the lesson design to support information processing and visual representations (chart, graphs, diagrams, illustrations) with descriptions (verbal and/or written text) from the first lesson plan to the second and third. They also showed evidence of understanding learning differences in the second and third lesson plan by presenting key content in different modalities, such as touch, body movement, and songs. Previous research showed similar findings. More teachers participating in the Dalton and Smith (2012) study accessed more than one form of representation. Only 12% of the resources teachers accessed for instruction using the online scaffolding UDL lesson plan tool were in one form of representation (text or visual); 39% accessed text and visual resources; and 50% accessed multiple means of representation that included podcasts, interactive video games, videos, pictures, and text (Dalton & Smith, 2012). When developmentally and ability appropriate visuals with written explanations were presented during instruction, learning outcomes significantly improved (Coyne et al., 2010; Marino et al., 2014; Merkt et al., 2007; Rappolt-Schlichman et al., 2007). However, a modality effect was found to be most effective when key content were highlighted (Kennedy et al., 2014; Leahy & Sweller, 2011; Yung & Paas, 2015).

Teachers in this study consistently implemented UDL representation guidelines that included strategies to activate prior knowledge, preteach vocabulary and critical prerequisites, and integrated technologies (educational software programs, Promethean board and Smartboard) in each of the three lesson plans. They implemented more technology-based multimedia that included videos and Powerpoint presentations with

audio and decreased their use of nontechnology-based materials like manipulatives and concrete objects from the first lesson plan to the second and third. Teachers participating in the Dalton and Smith (2013) study also accessed Internet-based resources to provide multimodal representations to enhance content-based subject matter and build background knowledge.

In a mixed-ability classroom, comprehension of essential vocabulary and supplied background knowledge are vital for communicating the standards-based curriculum to academically diverse student populations. Vocabulary gains increased when words were presented in visual and written format (Korat et al., 2014). Vocabulary gains were also positively associated with hyperlinks (Proctor et al., 2007), and supplied background knowledge via multimedia significantly improved reading comprehension when implemented in the lesson design (Coyne et al., 2010).

Expression Interpretation

This study showed a significant change in teachers' lesson plans in the level of application of Principle II following UDL professional training that is consistent with existing research. The Spooner et al. (2007) study also showed a significant within-subject expression pretest/post-test effect ($p < .001$). UDL training increased preservice teachers' ability to implement expression guidelines in the lesson design as this study did for inservice teachers.

The means for the Expression score (see Table 1) increased from Level 1 to Level 2, indicating that teachers' lesson plans had changed following UDL professional training. The mean score from Level 2 to Level 3 did not change, indicating that most

teachers had sustained UDL implementation in the lesson design 2 months after the received training. The results of the Spooner et al. (2007) study also showed an increase in preservice teachers' mean scores for the expression dependent variable between experimental pretest/post-test scores when compared to control group pretest/post-test scores. Inservice teachers from each of the three school districts participating in the Baldiris Navarro et al.'s (2016) study also demonstrated a considerable amount of growth for expression when pretest/post-test mean scores were compared.

Although teachers implemented more UDL expression guidelines in the lesson design in the second and third lesson plan, the majority of teachers participating in this study did not integrate the assistive technologies offered in the training to fully engage students with disabilities in the standards-based curriculum. Guideline 4 recommends teachers implement ATs in the lesson design for student engagement (CAST, 2011). Unlike teachers in this study, teachers who participated in the van Kraayenoord et al. (2014) study implemented text-to-speech software, word processing spell checks, and word prediction software in the lesson design following UDL inservice training to support lower level functions for students with learning disabilities in the inclusive setting. All of the teachers participating in this study taught special education students whether they were general education or special education teachers in the inclusive setting, or special educators in the confined special education classroom. Only one teacher who was a special educator in the confined special education classroom implemented assistive technologies in the curriculum to fully engage students with cognitive impairments in the standards-based curriculum.

Teachers in this study did use Promethean boards and Smartboards to engage students that have AT features during interactive instruction; however, teachers did not document whether these features were used in their lesson plans. Students with learning disabilities and low performing students need support for basic academic skill development and supplied background knowledge to fully engage in conceptual learning experiences based on the standards-based curriculum. When the contextual features of a universally designed digital learning environment included AT, support for basic academic skill development and background knowledge, students were able to engage in higher order thinking processes (King-Sears et al., 2015; Rappolt-Schlichtman, 2013).

Guideline 5 recommends using multimedia for student engagement, providing feedback, and scaffolding lower level function (CAST, 2011). Teachers in this study provided nontechnology-based options for students to express what they have learned (i.e., poster presentations, drawings, constructing a book or foldable, acting out, singing) and used alternative printed text (i.e., newspapers, magazines, internet resources) in the second and third lesson plans following UDL training. Unlike the CAST case studies (Meo, 2008) and the Dalton and Smith (2012) study, teachers in this study did not use technology-based multimedia for construction and composition. They implemented more interactive technologies and games with built-in features to engage students in learning in the second and third lesson plans. Students in the CAST case studies engaged students in a variety of technology- and nontechnology-based ways to express learning; they performed an enactment with a team, developed multimedia presentations, wrote a book for another grade level, wrote poems, and conducted research projects (Meo, 2008).

Thirty-two percent of the teachers participating in the Dalton and Smith (2012) study asked students to create projects that only required a written response and 58% asked students to create projects that had text and visuals.

Guideline 6 supports higher level functions with scaffolds, exemplars, rubrics, and goal-setting strategies (CAST, 2011). Teachers in this study implemented graphic organizers, story webs, and memory/sensory charts for student engagement in the second and third lesson plan to guide strategic thinking. Teachers participating in the van Kraayenoord et al. (2014) study also implemented options to guide strategic thinking that included graphic organizers in the lesson design; however, they also used word-making and explicit reading comprehension digital tools. Fifty-four percent of the teachers participating in the Dalton and Smith (2012) study took advantage of the scaffold strategic options designed to support critical thinking in the online learning environment.

Only a few of the teachers in this study documented the use of exemplars and rubrics to communicate student expectations, and prompts and self-regulating strategies to support metacognition. When modeled exemplars and faded scaffolds were used simultaneously during instruction, students improved their ability to solve problems independently (Atkinson & Renkle, 2002; King-Sears et al., 2015). Students with learning disabilities and low performing students need scaffold explicit instruction to support lower level and higher level executive functions (King-Sears et al., 2015; Lu & Bera, 2005; Marino et al., 2010). Teachers participating in this study may have used cues, prompts and self-regulating strategies during verbal interactive instruction and

small group instruction for students who needed additional support, but they did not document them in their lesson plans. However, teachers did document that they provided constructive feedback based on formative assessment data in the second and third lesson plan after the received training.

Engagement Interpretation

This study showed a significant change in teachers' lesson plans in the level of application of Principle III following UDL professional training that is consistent with existing research. The Spooner et al. (2007) study showed a significant within-subject engagement pretest/post-test effect ($p = .011$). UDL training increased preservice teachers' ability to implement engagement guidelines in the lesson design as this study did for inservice teachers.

The means for the Engagement score (see Table 1) increased from Level 1 to Level 2, indicating that teachers' lesson plans had changed following UDL professional training. The mean score from Level 2 to Level stayed relatively the same, indicating that most teachers had sustained UDL implementation in the lesson design 2months after the received training. The results of the Spooner et al. (2007) study also showed an increase in preservice teachers' mean scores for the engagement dependent variable between experimental pretest/post-test scores when compared to control group pretest/post-test scores. Inservice teachers from each of the three school districts participating in the Baldiris Navarro et al. (2016) study also demonstrated a considerable amount of growth for engagement when pretest/post-test mean scores were compared. Only two other

studies on UDL lesson plan development reported engagement findings (McGhie-Richmond and Sung, 2013; Williams et al., 2012).

Teachers in this study implemented fewer engagement guidelines in the lesson design than representation and expression guidelines. Studies that have analyzed engagement following UDL lesson plan development training have shown similar results. Preservice teachers in the Williams et al. (2012) study used a self-assessment tool to rate their proficiency for implementing UDL principles in the lesson after participating in a course designed to prepare them to teach in inclusive classrooms. Eighty percent of preservice teachers rated themselves as proficient for implementing Principle I in the lesson design, 67% rated themselves proficient for implementing Principle II, and only 60% rated themselves as proficient for Principle III. Guideline 9 is the guideline that is practiced the least in classrooms, because it focuses on developing students' intrinsic motivation through self-regulation (Lapinski et al., 2012). Only one of the teachers participating in this study implemented self-regulating strategies in the lesson design, but these strategies were implemented for behavioral monitoring and not for self-regulated learning. McGhie-Richmond and Sung (2013) found that preservice teachers made fewer revisions to existing lesson plans for Guideline 9 than practicing teachers; however, the researchers did not indicate how many preservice and inservice teachers implemented Guideline 9 or the kind of strategies they used. When self-regulating strategies were embedded in instruction to help students develop intrinsic motivation, academic performance improved (Davis et al., 2011; Ratton et al., 2012; Yeager & Dweck, 2012).

Findings were not reported for Guideline 7 and Guideline 8 in previous studies; however, teachers in this study implemented these guidelines in the lesson design following UDL lesson plan development training. They engaged students in cooperative learning activities, offered students choices for engagement, and personalized instruction so students could see the relevance of learning in the second and third lesson plan. Choice has been shown to be most effective when intrinsic motivation was involved instead of extrinsic motivation like rewards (Patall, 2008; Schuh & Farrell, 2006). Teachers also adjusted the level of challenge for their student population to minimize frustration and optimize learning and used scaffold peer-mediated instruction. Scaffold peer-mediated instruction has been shown to improve learning outcomes for students with learning disabilities (Tsuei, 2014) and students without learning disabilities (Kong, 2008; Tsuei, 2011). Students with learning disabilities felt more included in general education classrooms when peer-mediated instruction was used (McMaster et al., 2006). Research has also shown social-emotional benefits for K – 12 students when peer-mediated learning was implemented in mixed-ability classrooms (Gingburg-Block et al., 2006; Miller et al., 2011).

Teachers in this study embedded more rewards (i.e. displaying the best poster in the classroom) in the third lesson plan than in the first and second. Intrinsic motivation has been shown to positively impact learning; however, extrinsic motivation, like rewards do not (Assor et al., 2002; Nichoopour et al., 2013; Patell et al., 2008; Schuh & Farrell, 2006). A few teachers implemented strategies to support goal attainment (i.e., checklists,

progress worksheets, peer assessments, and self assessments) in the second and third lesson plan. One teacher documented social rules and classroom rules in each of the three lesson plans, and only two teachers provided opportunities to foster community engagement in the second lesson plan.

Limitations of the Study

This study was conducted as a repeated measure design to demonstrate discontinuity in the pattern of pretreatment and post treatment responses. Teachers' lesson plans were collected at three data collection time points to examine the changes in teachers' lesson plans before UDL professional training, immediately after the training, and 2 months after the training. Lesson plans that teachers normally create for their students using the district lesson plan template were collected instead of requiring teachers to use a UDL lesson plan template that would require them to provide responses for UDL representation, expression, and engagement guidelines.

Each of the five school districts had teachers use a different lesson plan template to document the lesson that is implemented in their classroom; however, the lesson plan components needed to conduct an evaluation according to the scoring rubric (Figure 2) were provided in each of the five lesson plan templates: Learning Objective(s), Instructional Methods, Procedures and Activities, Materials and Resources, and Assessments/Evaluations. The content of these components were cut from each of the five school district lesson plan templates and pasted into a Standardized Lesson Plan Template (Appendix E) for analysis at each of the three data collection time points.

The approach of using a standardized lesson plan template instead of a UDL lesson plan template for analysis was implemented to not disrupt teachers' natural lesson plan development routine or manipulate the findings of this study. Although a standardized lesson plan template provides opportunities for teachers to document UDL representation, expression, and most engagement guidelines, they limit opportunities to document elements of engagement guidelines that include "minimize threats and distractions" (CAST, 2011, p. 29) and "facilitate personal coping skills and strategies" (CAST, 2011, p. 33). These are strategies that most teachers implement in their classroom routine, but do not document on their lesson plan. Although most teachers did document more UDL engagement guidelines from the first lesson plan to the second that pertain to academic instruction and the results of this study showed a significant difference in teachers' lesson plans between conditions for the Engagement dependent variable, the scores were lower than Representation and Expression dependent variable scores. This may indicate that teachers did not fully document UDL engagement guidelines in their lesson plans or that additional or more in-depth training is needed for UDL engagement.

This study was carried out as proposed. Methods were implemented in the design to strengthen the content validity, construct validity, and empirical validity by using statistical analysis to control the internal and external validity (Shadish et al., 2002). The content validity of the instrument (Figure 2) "was measured by an expert panel composed of a special education professor with expertise in curriculum adaptation, a math education professor who was experienced in inclusive practices, and a research

associate with expertise in research on literacy” (Spooner et al., 2007, p. 111). The researchers designed the rubric, and a panel of experts determined whether the instrument accurately represented the three UDL principles (Spooner et al., 2007).

To obtain reliability in data collection for this study, an inter-rater agreement was used to score the lesson plans according to the instrument (Figure 2). Reliability checks were conducted mid-way through data scoring for each of the three data collection time points to prevent rater drift. The district representatives from each of the five school districts evaluated the 10-hour online interactive UDL professional development training by completing the Procedural Fidelity Checklist for UDL Training (Appendix B).

In terms of internal validity, issues of history initially arose concerning whether changes in teachers’ lesson plans could be attributed to the UDL professional training. The first lesson plan was collected before teachers started the training, and the second lesson plan was collected after teachers completed the training. The third lesson plan was collected 2 months after teachers completed the training. Each of the five school districts started and completed the training at different time points from August 2015 to October 2015. This flexible timeframe was allotted to accommodate each district’s schedule.

Teachers independently engaged in the online interactive training environment during their hourly PLC time each day over the course of a 2 to 4 week period. I monitored training participation in the Blackboard Coursesites training environment to validate completion of training requirements and start and completion dates. Special educators needed longer than 2 weeks to complete the training, because they needed to be

trained on new IEP forms and procedures. Some were delayed in completing the training due to technical problems; others encountered unexpected parent/teacher conferences. Although teachers needed additional time to complete the training due to their normal duty requirements, at no time throughout the course of the study did teachers engage in any other UDL training.

The results of this study can only be generalized to schools that employ teachers with similar demographics. A naturally formed convenience sample of 17 teacher volunteers were evaluated for their ability to create universally designed lessons following a 10-hour online interactive UDL professional training that was implemented in five school districts in the state of Mississippi. Regarding internal validity, the lack of control or comparison and the inability to assign teachers to the intervention posed a threat. This is true for most quasi-experimental research that uses nonprobability sampling (Frankfort-Nachmias & Nachmias, 2008). There is also limited research on this population for comparison to these results.

Recommendations

It would be beneficial if future UDL lesson plan development training and research considered current research pertaining to the UDL framework and how it affects student learning. Teachers would benefit if future training initially addressed basic knowledge pertaining to the learning sciences and educational neuroscience, so teachers could see the value of engaging students in learning experiences that emphasize key content and learner variability before introducing the UDL framework as a guide for lesson plan development. Most teachers teaching in K – 12 classrooms are

knowledgeable about implementing evidence-based learning strategies, inquiry-based learning, project-based learning, and differentiated instruction in their classrooms; however, they may not fully understand the importance of implementing them. The UDL framework guides teachers as they develop lesson plans based on their existing teaching and learning practices to ensure that the appropriate supports are implemented in the lesson design in order to effectively communicate the curriculum to every student in the classroom. For example, by understanding differences in strategic brain network processes, teachers can create one differentiated lesson with embedded faded scaffolds based on student need to allow for leverage and fully engage all students using evidence-based strategies (i.e., graphic organizers or reading comprehension strategies).

Veteran teachers who participated in this study were able to implement more UDL guidelines in the first lesson plan collected before the received training than teachers with 1 – 5 years teaching experience. Future training should consider developing a community of learners and ask veteran teachers to coach new teachers on how to develop universally designed lessons. The instrument used in this study (Figure 2) would be appropriate to use in another study that evaluates teachers' lesson plans following UDL training based on the UDL framework. Future research should incorporate larger samples that will help to ensure sufficient power and a control group for comparison.

Teachers in the current study used more multimedia for representation in the second and third lesson plans collected after the received training; however, they did not use the digital collaboration and multimedia tools provided in the training for student

expression and engagement. They primarily used educational software and interactive websites to engage students. Prepackaged digital resources may not accommodate the academic needs of a diverse student population or fully engage students in the curriculum (Marino et al., 2011; Tsuei, 2014). Assistive technologies have the ability to differentiate instruction and support basic academic skill development, metacognition, and supply the background knowledge needed to fully engage all students (Zascavage & Winterman, 2009). Students with learning disabilities who have working memory deficits and students who lack the basic academic skills and background knowledge needed to fully engage in the standard-based curriculum need additional support. When teachers create their own digital instruction for the technology centers in their classrooms, they can adjust the level of challenge for their student population, incorporate the appropriate scaffolds, and enhance student learning with multimedia. Teachers would benefit if future UDL lesson plan development training demonstrated how to use instructional digital resources to help them create meaningful technology learning centers for their student population. Future research should focus on teachers as instructional designers to explore the different ways digital instructional tools can be used to engage diverse learners in the curriculum.

Teachers participating in the current study improved their Engagement score from the first lesson plan before the received training to the second lesson plan after the received training; however, scores slightly decreased from the second lesson plan to the third. Minimum Engagement scores did not increase from the first lesson plan to the

second and third lesson plan collected after the received training, and overall Representation and Expression scores were higher than Engagement scores. Teachers would benefit if future training provided a more extensive or indepth engagement training for UDL lesson plan development that emphasizes self-regulation so teachers can see the holistic value of developing and sutaining an intrinsic motivation to learn. Self-regulating strategies can be incorporated in classroom management, instruction, Individualized Behavior Intervention Plans, and IEPs. Some UDL guidelines may not be documented in traditional standardized lesson plan templates. Future researchers should develop an observation instrument based on UDL engagement guidelines to conduct classroom observations.

Implications

Twenty-first century K – 12 schools should focus less on quantity – more after-school tutoring programs and remediation that isolate students who perform below average and students with disabilities from their peers – and more on the quality of education. The social change objective for this study was to improve the quality of teaching and learning in mixed-ability classrooms and to connect research to practice. UDL lesson plan development training was implemented for teachers in five school districts in the state of Mississippi to find out how to better prepare teachers to teach students with diverse physical, cognitive, and social-emotional needs. The goal of the training was to arm teachers with the knowledge and resources they would need to meet the challenge of teaching a diverse student population.

This study promotes positive social change by addressing the need to accommodate academic diversity in K – 12 classrooms. A better understanding of the learning sciences and the three brain networks that pertain to learning may result in the development of lesson plans that accommodate the learner variability that exists in every classroom. Teachers participating in this study demonstrated an ability to develop lessons based on the UDL framework in the second and third lesson plan after the received training. Teachers in this study also showed evidence of understanding learning differences in the second and third lesson plan by presenting key content in different modalities, such as touch, body movement, and songs.

The results of this study bring about interesting implications for K – 12 curricula coordinators who design and implement professional development for teachers in their district. The results indicate that teachers need training on how to use and integrate digital instructional tools in curricula in order to create meaningful technology learning centers for their students that provide assistive technology support and support for metacognition, basic academic skill development, background knowledge, and foster collaboration, composition, and construction. Additionally, school counselors and behavioral interventionists have the expertise and resources to support teachers with the implementation of UDL engagement guidelines by helping them develop classroom management strategies and cognitive behavioral self-regulating interventions based on those guidelines.

This study is an important contribution to the existing literature on UDL lesson plan development. The results of the study will also add to the body of knowledge by

enhancing an understanding of how to support teachers who teach diverse learners. The results and the knowledge gained from this study will be presented at the five school districts who participated in the study. The results will also be shared with the Mississippi Department of Education in an effort to implement UDL professional lesson plan training throughout the state.

Conclusion

The goal for this research was to determine whether teachers' lesson plans would change after participating in a 10-hour online interactive UDL professional development training that I designed based on the UDL framework. The results clearly indicated a significant difference between the first lesson plan collected before the training and the second lesson plan after the training for each of the four dependent variables (Total Score, Representation, Expression, and Engagement). The results also showed that teachers sustained UDL implementation in the lesson design 2 months after the received training.

The UDL framework is based on cognitive science and educational neuroscience research (CAST, 2011), connecting research to practice. The framework guides teachers as they develop one meaningful universally designed lesson based on the physical, cognitive, and social-emotional needs of their specific student population, reducing the need to make modifications to lesson plans after they have been created (Meo, 2008). Prepackaged nontechnology-based (textbooks) and technology-based (educational software and interactive websites) instructional materials do not accommodate academic diversity or provide personal relevance for students. They also create dependency for

lesson plan development, and teachers miss the opportunity to fully develop the art of teaching and curricula design.

Technology will never replace the teacher as an instructional designer because diversity will always exist. A combination of technology and nontechnology-based materials are needed to engage all the senses. The social implication that schools offer cannot be offered in an online learning environment. The K – 12 grade teacher will always be the primary communicator of the standards-based curriculum in K – 12 education. Therefore, it is vital that we arm K – 12 instructional designers with the knowledge and resources they will need to meet the challenge of teaching a diverse student population and research ways to improve the quality of education in mixed ability classrooms.

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Appendix A: Invitation Letter

You are invited to partake in a Universal Design for Learning (UDL) lesson plan development training research study that explores the impact UDL training has on curricula development. This study is being conducted by a researcher named Georgeann Winter, who is a doctoral student at Walden University. Participation in this study is not a requirement for attending the district-sponsored UDL professional development training. Attending the training qualifies you as a participant for this study. However, to qualify as a participant in this study you must agree to not engage in any other UDL training throughout the course of this study.

The purpose of this study is to investigate the effect UDL teacher training has on lesson plan development. The UDL framework was created by the Center for Applied Specialized Technology. It is based on neuroscience and cognitive science research. The framework is designed to support teachers who teach academically diverse student populations develop curricula that accommodate the needs of students and allow them greater access to the standards-based curriculum. One universally designed lesson is created with built-in scaffolds and supports instead of multiple differentiated lessons.

Participation in this study is voluntary. If you choose to participate, you have the right to change your mind at any time during the study. All of the information you provide will be kept strictly confidential. The information you provide will only be used for the research project. The researcher and an inter-rater will evaluate the lesson plans according to a valid UDL lesson plan evaluation rubric. Your name will be removed from the lesson plans and coded before the inter-rater evaluates them to protect your privacy and confidentiality, and all email correspondences between the researcher and inter-rater will be password protected. At no time will the researcher reveal the names of the teachers and the district. When the study is published, only coded data of the UDL lesson plan rubric evaluation results and coded teacher demographic information will be revealed.

If you agree to participate in this study, you will be asked to:

- Provide the following demographic information: gender, degree, years teaching, and certification status.
- Submit your lesson plans directly to me at three time points: 1) before training, 2) immediately after training, and 3) two months after training.

If you are interested in participating in this study, please contact me directly via email.

Thank you,
Georgeann Winter

Appendix B: Demographics Request

Research Study Participants:

Thank you for agreeing to participate in this research study. Your participation will contribute to the quality of teaching and learning in mixed-ability classrooms. Please take a moment of your time to provide the following information by placing an "X" next to the selection that indicates your gender, degree, number of years teaching, and certification status, and email the information to me within a week of receiving this email. As indicated in the Informed Consent Form, the information will be coded and your identity will not be revealed.

1. Gender: Male Female
2. Degree: Bachelor Master Education Specialist PhD, Ed D
3. Number of Years Teaching: 1-5 6-10 11-15 15-20
 20+
4. Certification Status: (Please indicate all that apply)
 Elementary Education
 Secondary Education
 Special Education
 General Education

Sincerely,
Georgeann Winter
Doctoral Student/Researcher Walden University

Appendix C: Permission to Reproduce the Instrument

Spooner, Fred

to me, Diane

Georgeann,

THANK YOU for your messages, as I received both the voice mail message, and the E-mail message that you thought was not delivered. I am responding to the E-mail message. You have our permission to use the rubric from the Spooner, Baker, Ahlgrim-Delzell, Harris, and Browder (2007) UDL study.

Spooner, F., Baker, J., Ahlgrim-Delzell, L., Harris, A., & Browder, D. M. (2007). Effects of training in universal design for learning (UDL) on lesson plan development. *Remedial and Special Education*, 28,108-116.

Bye,

Fred

Fred Spooner, Ph.D.
Department of Special Education
and Child Development
College of Education

From: Georgeann Winter
Sent: Thursday, June 05, 2014 1:53 PM
To: Spooner, Fred
Cc: Browder, Diane
Subject: Permission to use Instrument

Appendix D: Standardized Lesson Plan Template

Code: (for researcher use only)
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Lesson Plan Template
Learning Objective(s):
Instructional Methods/Procedures and Activities:
Materials/Media:
Assessments/Evaluations:

Appendix E: Procedural Fidelity Checklist for UDL Training

(Please respond with a yes or no)

1) The presentation represents training information in a variety of ways to address the diversity of the participant audience. Response:

2) The presentation provides participants with alternative and varied ways to interact with the training content. Response:

3) The presentation uses teaching methods and techniques that are pedagogically effective for all participants. Response:

4) The presentation uses multiple means of evaluation to accurately measure progress toward achieving the training goals. Response:

(adapted from CAST, 2004).